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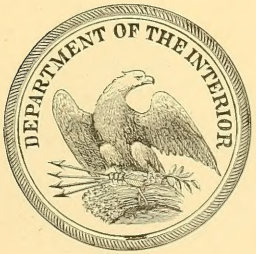

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UNITED STATES GEOLOGICAL SURVEY
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THE

LATER EXTINCT FLORAS OF NORTH AMERICA

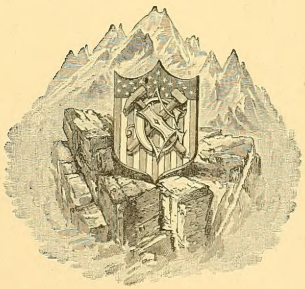
BY

JOHN STRONG NEWBERRY

A POSTHUMOUS WORK

EDITED BY

ARTHUR HOLLICK



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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., June 8, 1897.

SIR: I have the honor to transmit herewith the manuscript and plates of a posthumous work on the Later Extinct Floras of North America, by Dr. John Strong Newberry, edited by Dr. Arthur Hollick, and to request its publication as a monograph of the Survey.

Very respectfully,

F. H. KNOWLTON,
Assistant Paleontologist.

Hon. CHARLES D. WALCOTT,
Director.

EDITOR'S PREFACE.

This volume has been prepared, in its present form, under somewhat peculiar circumstances. An edition of twenty-five plates, without text, was printed about 1871. These were issued under the title, Illustrations of Cretaceous and Tertiary Plants of the Western Territories of the United States, in 1878. Subsequently a revised edition of these and forty-three additional plates was published, but was withheld from distribution, awaiting the completion of the text by Dr. Newberry. His sickness and subsequent death stopped further progress on the work, and much that he had accomplished went for naught. Upon two sets of the plates manuscript names for the figures were placed by him. One of these sets is in the possession of Dr. Lester F. Ward, and the other was in Dr. Newberry's library, which came into the possession of the Geological Department of Columbia University after his death. From these sources I was enabled to obtain a more or less complete list of the names which it was the evident intention of the author to give to the figures. Most of these were found to refer to descriptions previously published by Dr. Newberry,[1] or to species of other writers, notably Leo Lesquereux and Oswald Heer. A number, however, were apparently not referable to any published descriptions, and it became necessary to examine Dr. Newberry's manuscript, in order to connect these names, if possible, with his notes. A thorough search was also made

[1] Descriptions of fossil plants collected by Mr. George Gibbs, geologist to the United States Northwest Boundary Commission, under Mr. Archibald Campbell, United States Commissioner: Boston Journ. Nat. Hist., Vol. VII (1863), pp. 506–524.

Notes on the later extinct floras of North America, with descriptions of some new species of fossil plants from the Cretaceous and Tertiary strata: Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), pp. 1–76.

Brief descriptions of fossil plants, chiefly Tertiary, from western North America: Proc. U. S. Nat. Mus., Vol. V, 1882 [February and March, 1883], pp. 502–514.

for the type specimens, and all labels upon these were noted and compared with the names upon the plates and with the manuscript notes. By these means it has been possible to ascertain, in nearly every case, the name which Dr. Newberry intended to use.

Those who have had access to the plates upon which he placed his names have always endeavored to preserve these names by referring, whenever occasion demanded it, to "Newb. MSS. undistributed plates, U. S. Geol. Surv." This, however, could not be recognized as publication, and in the lapse of time some of the names were used for other species and under the rule of priority could no longer be retained for those of Dr. Newberry. It is also to be noted that names of such species as existed in manuscript only were liable to be superseded by published names of other authors, and under such circumstances Dr. Newberry's names would have to be dropped and the others substituted. One instance in this connection is *Sabal occidentalis*, Newb. MSS., which became *S. imperialis* Dn.

In arranging the text it has been thought desirable to quote Dr. Newberry's original published description in each instance, followed by his subsequent manuscript notes, whenever such could be obtained. In case a manuscript description was found for any unpublished species it has been included in full. In the event of no published or manuscript description having been found for any species, such name or memorandum as could be found in connection with the specimen was adopted and a note to that effect included over the editor's initials. In the case of but one figure could absolutely no clue be obtained as to its probable reference by Dr. Newberry.

In regard to the volume entitled Illustrations of Cretaceous and Tertiary Plants, etc., Dr. Newberry would never acknowledge any responsibility, the names accompanying the plates having been supplied by Lesquereux, at the request of Dr. F. V. Hayden, then director of the United States Geological Survey, without Dr. Newberry's sanction, and it was evidently his intention and desire to correct in the present volume several errors which appear in that one. In each instance, therefore, in which the same figure appears in both volumes the fact is noted, with any correction which was found necessary.

The work is confessedly incomplete in certain respects, due to loss of type specimens and absence or incompleteness of manuscript, and many of Dr. Newberry's reasonings and conclusions would probably not be

included if revised by him at the present time. These must, therefore, be accepted merely as reflecting his opinions at the time when they were written, the editor not feeling himself at liberty to alter them, and thus perhaps making Dr. Newberry appear to say what he might not have intended to say. It contains so much of value, however, and its contents are referred to so frequently, that the publication has become necessary both as a matter of scientific record and for purposes of research.

A. H.

THE LATER EXTINCT FLORAS OF NORTH AMERICA.

By John Strong Newberry.

DESCRIPTIONS OF SPECIES.

CRYPTOGAMIA.

PTERIDOPHYTA.

Order FILICINÆ.

Lygodium Kaulfussi Heer.

Pl. LXII, figs. 1–4.

Fl. Skopau; Beitr. naher Kent. Sachs.-Thuring. Braunkohl, Vol. XVIII (1861), p. 409, Pl. VIII, fig. 21; IX, fig. 1.

Lygodium neuropteroides Lesq. Hayden's Ann. Rept. 1870 [1872], p. 384; Tert. Fl. (1878), p. 61, Pl. V, fig. 4–7; VI, fig. 1.

Dr. C. A. White has collected from the Green River shales a splendid series of the fronds of a Lygodium which is apparently identical with that described by Lesquereux under the above name. These illustrate the growth of the plant far better than those he figures, and some of the more interesting and instructive ones are therefore now figured. Coming all from the same locality, indeed thickly impacted together and having the same nervation, they unquestionably represent a single species, and yet it will be seen that if diversity of form were accepted as affording specific distinctions half a dozen species might be made from them; hence we are taught by them that the fossil species of Lygodium already described are based on too insufficient material, and should have comparatively little weight until confirmed by further evidence. The number of figures now given, however, enable us to define this species in such a way that it is not liable to be mistaken.

As these fronds occur in the rock, the margins seem to be undulated and the lobes considerably curved and twisted. How much of this is due

to contraction in drying before they were submerged and how much is natural it is now impossible to say; but specimens from Currant Creek, Oregon, exhibit the same peculiarity, the lobes being sometimes almost fan-shaped, the margins waved or involute, and recalling by their mode of growth the fronds of Marchantia, repeating what is so conspicuous in the Green River shales. We must therefore regard the characters enumerated as normal.

The nervation is in most specimens clearly defined and rather strong. It is crowded as compared with that of some other species, and is confluent along the middle of the lobes, precisely as in Neuropteris, without producing a midrib.

Professor Heer has described and figured in his great work on the plants of the Swiss Tertiaries (Fl. Tert. Helv., Vol. I, p. 42, Pl. XIII, fig. 3, and Vol. III, Pl. CXVII, fig. 25b) a species of Lygodium which evidently closely resembles this; so much so that unless some distinctive characters are furnished by the lobing of the fronds, they are likely to prove identical. Professor Heer names his species *L. acutangulum*, from the nervation, which is identical with that of the Green River specimens, but he describes the frond as three-lobed. His specimens are, however, very imperfect, and two or three lobed specimens could be selected from the suite before me which would, taken by themselves, require a description corresponding precisely with that given by Heer.

Among the fronds collected by Dr. White at Green River is one which has much narrower lobes than the others, and it has apparently a finer nervation; but it is unfortunately much weathered, and the details of structure are rendered obscure. A figure is now given of it (Pl. LXII, fig. 2), but I am inclined to regard it as only one of the many forms of one protean species.

Since the above notes were written Messrs. Gardner and Ettingshausen have published their Monograph of the British Eocene Flora, Vol. I, Filices, and on Pl. VII have given a number of figures of *Lygodium Kaulfussi* Heer, with which they identify Lesquereux's species; a conclusion to which he also subscribes. It will be seen, however, by a comparison of Lesquereux's figures with those now given and with those published by Heer and Gardner that the American fern had larger pinnæ with broader and less undulate lobes, which are nearly of the same breadth from base to summit.

Among hundreds of specimens from Green River which I have examined there are very few which have the lobes of the pinnæ as narrow as are represented in the plates and descriptions of the fossil plant, and none which can be compared with the narrower and more undulate forms given by Gardner on Pl. VII, figs. 1 and 4, of Eocene Ferns. However, the nervation is essentially the same, and the fructification which has been recently found presents no obvious points of difference. I am therefore inclined to accept the view of Messrs. Gardner and Ettingshausen that all these so closely resembling fronds of Lygodium found in the later Cretaceous and older Tertiary rocks of Europe and America should be regarded as belonging to one species.

From the coal-bearing rocks of Fletts Creek and Carbonado, Washington, I have a few fronds and fragments of fronds of a species of Lygodium which offer no characters by which they can be distinguished from those found in the Green River group, and it seems to me probable that we have in all these specimens relics of one of those widespread and long-lived species which occur at different geological horizons among both animal and plant remains.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Anemia perplexa Hollick.[1]

Pl. XV, figs. 1, 1a; XVI, fig. 3; LXIII, figs. 1–4.

Sphenopteris (*Asplenium*) *elongatum* Newb. Boston Journ. Nat. Hist., Vol. VII (1863), p. 511.

Asplenium subcretaceum Sap. ? Fl. Foss. Sez., Mem. Soc. Geol. France, Ser. II, Vol. VIII (1868), p. 315, Pl. XXIII, fig. 4.

Gymnogramma Haydeni Lesq. ? Hayden's Ann. Rept. 1871 [1872], p. 295; Tert. Fl. (1878), p. 59, Pl. V, figs. 1–3.

Anemia subcretacea (Sap.). Gard. and Ett. ? Monog. British Eocene Flora, Vol. I, Pt. II (1880), p. 45, Pls. VIII, IX.

"Frond bi- or tri-pinnate; pinnæ lanceolate, or linear, acute; lower ones broadly lanceolate, pinnatifid at base, margins deeply double-toothed,

[1] Under the rules of nomenclature as now accepted the original specific name given to this plant by Dr. Newberry can not be retained, as it is antedated by that of a living species—*Asplenium elongatum* Swartz (1806).

The relationships of the foreign, western, and eastern United States forms are further discussed by Dr. Newberry in his Flora of the Amboy Clays (Mon. U. S. Geol. Surv., Vol. XXVI, pp. 38–42), under the species of Asplenium and Anemia there described.

Dr. Newberry evidently intended to maintain the species now described and figured as distinct, and as the original name is not available I have been obliged to adopt an entirely new one.—A. H.

upper ones narrow lance linear, wedge-shaped at base, summit long-pointed, acute margins coarsely toothed; nervation strongly marked, acute-angled, medial nerve of pinnæ vanishing toward the summit, secondary nerves diverging from this at a very small angle, radiating to the margins, dichotomously forked."

A number of figures are now given of a fern, specimens of which have been collected at Point of Rocks, Wyoming; Golden and Erie, Colorado, and Bellingham Bay and Carbonado, Washington. In general character it so closely resembles *Gymnogramma Haydenii*, figured by Lesquereux (Tert. Fl., Pl. V, figs. 1–3), that it can hardly be considered distinct, but a few minor differences render it possible that we have here only two closely allied species. Lesquereux shows and describes the nervation of his fern as finer and simpler than that represented in our figures; but he states that the nervation is obscure in his specimens, and that it seems to have been buried in the parenchyma. The same is true of the specimens before us, and the distinctness of the nervation is exaggerated in the figures; but it can be plainly made out in some portions of the frond, and is more open and stronger than is shown in Lesquereux's plate. The reference of this plant to Gymnogramma is conjecture only; and the question of its botanical affinities can only be decided when fruiting fronds shall be found. The fossil is a marked one, however, and the figures and descriptions of it will serve a good purpose, whatever generic name may be hereafter given to it.

Previous to the description by Lesquereux (1871) Count Saporta had described (Fl. Foss. Sezanne (1868), p. 315, Pl. II, fig. 4) a very similar fern under the name of *Asplenium subcretaceum*. This was more fully illustrated by Gardner and Ettingshausen (Mon. British Eocene Flora, Vol. I, Pt. II (1880), p. 45, Pls. VIII and IX), and called by them *Anemia subcretacea*. Lesquereux, Saporta, and the authors of the British Eocene Flora are agreed in considering the specimens from Wyoming, Sezanne, and Bournemouth as belonging to the same species. The large number of specimens of the fern which I have from Point of Rocks and Puget Sound show that while apparently identical with that figured by Lesquereux (Tert. Fl., p. 59, Pl. V, figs. 1–3), it differs so much from the foreign specimens that we must regard it as at least a strongly marked variety. Some fragments of pinnæ figured by Mr. Gardner—such as those given on Pl. VIII, fig. 1, Pl. IX, figs. 3 and 5—approach closely to the American plant, but we nowhere find here

pinnæ with long, linear-notched pinnules which seem to form the most striking characteristic of the foreign fern. Among all my specimens I have nothing which resembles those figured on Pl. VIII, fig. 2, or Pl. IX, figs. 1, 2, 4, of Eocene Ferns.

Lesquereux's specimens were collected by Dr. Hayden on the divide between the headwaters of Snake River and Yellowstone Lake. Those now figured are from Bellingham Bay, Washington; Erie, Colorado, and Point of Rocks, Wyoming. The strata exposed in the last two localities are now generally conceded to be Cretaceous, although Lesquereux has claimed that they are Tertiary, and the discussion which these diverse views have excited has given special value to all new paleontological material from that region. If it should be agreed that all the ferns here associated together represent but a single species, that is no proof that the rocks which contain all of them are at one geological level. Nearly all the widespread species of fossil plants and animals have also considerable vertical range, and the American specimens are so much broader and stronger that they constitute a distinct variety, such as may have lived at a little earlier epoch than the European plants which are regarded as specifically identical with them. The proofs of the Cretaceous age of the Lower Laramie of Colorado and Wyoming, viz, numerous Dinosaurs and Cretaceous mollusks, with the absence of animal or plant remains that are elsewhere found in Tertiary rocks, may be regarded as decisive of this question. Hence we can only say that if the leaf beds of Sezanne be regarded as Tertiary, it does not at all follow that the Laramie group is so simply because it contains a species closely allied to, or a distinct variety of, a fern found in these beds abroad. According to Mr. Gardner, *Anemia subcretacea* occurs at Bournemouth, but we know that the Bournemouth beds are somewhat later than those of Gelinden and Sezanne, and that they are on the horizon of the Fort Union beds of the upper Missouri country.

Count Saporta does not approve Mr. Gardner's transfer of his *Asplenium subcretaceum* to Anemia, and his reasons are quoted by the latter in the memoir already referred to, page 46. It would seem, however, that this question can not be decided without the fructification, and that has not yet been found. This is somewhat remarkable, considering the fact that already thousands of specimens of *Anemia subcretacea* have been collected. If it were a species of Asplenium, it seems hardly possible that the fruit should

be always absent, and this fact gives probability to the suggestion of Mr. Gardner that the fruit was borne upon independent fronds or stipes.

Mr. Gardner suggests that *Asplenium Foersteri* Deb. and Ett., described in the Urweltlichen Acrobryen des Kreidegebirges von Aachen und Maestricht, Pl. II, figs. 4, 7, 11, is also closely related to if not identical with *Anemia subcretacea;* but in a recent visit to Aachen I had an opportunity of examining some of Debey's original specimens, and it seemed to me they were very distinct from *A. subcretacea. A. Foersteri* is a thinner, more delicate fern, with few and slender nerves and with pinnæ irregularly lobed or undulate. I have identified this species among the plants from the Amboy clays, many of which also occur at Aachen. The Amboy clays are about on the horizon of the Dakota sandstones, and therefore very much older than the Laramie group.

Formation and locality: Cretaceous (Laramie group). Orcas Island, Bellingham Bay, Washington; Point of Rocks, Wyoming; Erie, Colorado.

Acrostichum hesperium Newb.

Pl. LXI, figs. 2–5.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 503.

"Frond large, pinnate; pinnæ linear, 1½ to 2 inches wide, 6 to 12 inches long, rounded at remote extremity, those in lower part of frond rounded or wedge-shaped at base, those above united by the entire base to the rachis and with each other; rachis of frond and midrib of pinnæ strong, smooth, somewhat sinuous; nervation reticulated, lateral nerves numerous, diverging from the midrib at an acute angle, anastomosing to form elongated six-angled areoles; fructification unknown."

This is a large and strong fern, represented in the collections by a number of specimens collected by Mr. C. A. White, which include portions from the lower and upper parts of the frond. In general aspect it much resembles *Acrostichum aureum* of Florida and the West Indies; but in that species the pinnæ are all separate and narrowed at the base, whereas in this plant near the summit of the frond they coalesce, forming a broadly palmated portion. Lesquereux, in his Tertiary Flora, p. 58, Pl. IV, fig. 2, describes a large fern with a somewhat reticulated nervation which he calls *Gymnogramma Gardneri.* The pinnæ must have been about as large and of similar form to those of the fern under consideration, and the nervation

is also reticulated; but in Lesquereux's plant the midrib of the pinna is much stronger and is channeled, while the lateral nerves anastomose much less frequently, and it is evident that the specimens represent distinct species. Until the fructification of this fern shall be discovered, its generic relations can not be said to be established. However, the resemblance in nervation and proportions of the frond to Acrostichum is so strong that the reference to that genus seems justifiable.

Mr. J. Starkie Gardner, in his Monograph of the British Eocene Flora, Vol. I, p. 26, figures and describes a large Chrysodium found in the Bagshot beds of Bournemouth, England, which he calls *Chrysodium Lanzæanum*, and which closely resembles that now under consideration. I find hardly any points of difference, except that Mr. Gardner represents the Bournemouth species as having a strong pinnate frond which terminates in a single lanceolate pinna which is drawn down to an acute base; whereas in our species, as will be seen by reference to the figures now published, the frond terminates above in a palmate divergence of the terminal and upper lateral pinnæ, the bases of which all coalesce. It is interesting, however, to find a species so closely allied to this foreign one at nearly the same geological level in this country.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Pteris pennæformis Heer.?

Pl. XLVIII, fig. 5.

Fl. Tert. Helv., Vol. I (1855), p. 38, Pl. XII, figs. 1a–1d.
Pteris pseudopennæformis Lesq.? Tert. Fl. (1878), p. 52, Pl. IV, figs. 3, 4.

Formation and locality: Tertiary (Miocene?). Currant Creek, Oregon.

Note.—I have been unable to find any manuscript relating to the above, except brief memoranda on plate and specimen to the names and locality here quoted.—A. H.

Pteris Russellii Newb.

Pl. LXI, figs. 1, 1a.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 503.

"Frond large, pinnate; pinnæ crowded, linear in outline, narrow, long-pointed above, attached to rachis by entire base; decurrent; length,

16 to 20 centimeters; width, 10 millimeters; margins undulate below, irregularly and coarsely toothed above; nervation fine, but distinct; branches all forked, leaving midrib at an angle of about 45 degrees, all twice or three times forked."

Only the upper part of the frond of this fern appears on the specimens examined, but these show a species apparently distinct from any hitherto described. In general form the pinnæ resemble those of *Pteris pennæformis* Heer (Fl. Tert. Helv., Vol. I, p. 38, Pl. XII, figs. 1–1d), and *P. pseudopennæformis* Lesq. (Tert. Fl., p. 52, Pl. IV., figs. 3, 4), but it differs from the first by being a stronger plant, with wider and more coarsely toothed pinnæ, and less simple nervation; from the second, by the same characters and in having the nervation less crowded, the nerve branches issuing at a greater angle, and oftener forked.

Pteris erosa Lesq. (Tert. Fl., p. 53, Pl. IV, fig. 8) has broader pinnæ, of which the margins are set with finer and more numerous teeth.

The species is dedicated to Mr. I. C. Russell, who first collected it, in Vermejo Canyon, New Mexico. It has also been collected at Walsenburg, Florence, and Golden, Colorado.

Formation and locality: Cretaceous (Laramie group). Vermejo Canyon, New Mexico.

Onoclea sensibilis fossilis Newb.

Pl. XXIII, fig. 3; XXIV, figs. 1–5.

Onoclea sensibilis, L., Newberry in Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 39; Ills. Cret. and Tert. Pl. (1878), Pl. VIII, fig. 1; IX, figs. 1–3.

"Frond pinnate, large; pinnæ, lanceolate in outline, with waved margins, more or less deeply lobed or pinnatifid, connate at their bases, forming a broad wing on the rachis of the frond; nervation strongly marked, more or less reticulated, the nerve of each lobe or pinnule springing from a common trunk, having a dendroid form, with waving branches, which often unite to form elongated lacunæ, of which the largest border the rachis of the pinnæ on either side, and are formed by the nerve branches of each lobe reaching over and touching, or closely approaching, the base of the nervation of the next superior lobe or pinnule."

The collection of fossil plants made at Fort Union by Dr Hayden contains a great number of examples of this beautiful fern, showing the

upper and under surface of the frond, the variation of form of the pinnæ of different fronds, and different parts of the same frond.

The robust habit of this plant, the strong, waved, and reticulated nervation and broadly winged rachis, which seem to distinguish it at a glance from all known fossil species, suggested a comparison with some of the strong-growing tropical ferns, and it was only after a laborious examination of all the genera of exotic ferns contained in the herbaria to which I had access that I was led to turn my eyes nearer home, and found in Onoclea a striking and unexpected resemblance to it.

The common form of *Onoclea sensibilis* grows abundantly in all parts of our country, and is one of the first plants collected by the youthful botanist. In this we have the rachis of the frond more or less winged, and a nervation on the same general plan with that of the fern in question, but more distinctly reticulated than in some specimens of the fossil. (See Pl. XXIII, fig. 4.) By this I was at first misled, but in examining Dr. Torrey's var. *obtusilobatus* I found the exact counterpart of the exceptional forms in the lobation of the pinnæ and in the nervation. (See Pl. XXIII, figs. 5, 6.) The gradation of characters in this variety is very great. In some specimens we have a distinctly bipinnate frond; the pinnæ composed of numerous remote, even obovate, pinnules, and the nervation not reticulated, the nerves of the pinnules radiating and forked, but never joining. This is the extreme form, but even here the rachis of the frond is more or less winged. In an intermediate form we find the rachis winged, the pinnæ deeply lobed, and precisely the nervation of the fossil. Even in the common form the nervation is similar in plan, and the elongated spaces, destitute of nerve branches on either side of the rachis of the pinnæ, form a noticeable feature in both.

The general aspect of the frond and the nervation in some species of Woodwardia is not unlike that of the fossil now figured, and until we shall have found the fruit it will not be possible to prove that this is Onoclea and not Woodwardia. The resemblance of the fossil to Onoclea in the form of the frond, the lobation of the pinnules, and in the style of nervation is, however, stronger than to Woodwardia, as will be seen by a comparison of Pl. XXIII, fig. 4—a portion of the frond of the living Onoclea—with Pl. XXIV, figs. 4 and 5, corresponding portions of the fossil. Among the large number of specimens obtained of this fossil fern there are none which

exhibit the fructification, an indication that this was borne on distinct fronds. If it were a species of Woodwardia it is almost certain that we should have found the fructification, since all the fronds of Woodwardia may be fruitful, and the fructification is generally observable in the fossil species of that genus.

Since the above notes were written I have obtained a number of specimens of Onoclea from the shores of Whatcom Lake, near Bellingham Bay, Washington. In this vicinity there is a great development of strata which are rich in fossil plants and are about the equivalents in time of the Laramie group; but, with few exceptions, the forms are distinct. This is one of the few which are common to the two localities.

Varying, as the living Onoclea does, in the size, outline, and nervation of the sterile frond—from 6 inches to 3 feet in height; from a finely reticulated to an open, dichotomous nervation; from a bipinnate frond with remote, obovate pinnules, to a pinnate form with wave-margined pinnæ and broadly alate rachis—it plainly includes all the characters of the fossils before us, and I therefore find it impossible to separate them.

This is apparently the plant described by Prof. E. Forbes (Quart. Journ. Geol. Soc. London, Vol. VII (1851), p. 103), under the name of *Filicites* (?) *hebridicus*, and obtained by the Duke of Argyle from the Island of Mull. It has also been met with by Professor Heer in collections of fossil plants from the Eocene beds of Atanekerdluk and other places in the arctic regions. (Fl. Foss. Arct., Vol. VII, p. 48, Pl. LXX, fig. 6.)

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Lastrea (Goniopteris) Fischeri Heer?.

Pl. XLVIII, fig. 6.

Fl. Tert. Helv. Vol. I (1855), p. 34, Pl. IX, figs. 3a–3c.

Lastrea (*Goniopteris*) *Knightiana* Newb. Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 503.

"Frond large, tripinnate; pinnæ linear, 2 centimeters wide, 14 to 16 centimeters long; pinnules diverging at a large angle, united for two-thirds of their length, upper third free, pointed, and curved upward; venation clear and exact, midrib reaching the extremity of the pinnule; the lateral nerves about ten on either side, parallel, curved upward."

This beautiful fern may be readily recognized by the rigid exactness of its outline, the regularity and precision of its crowded nervation, and by the falcate curvature of the extremity of the acute pinnules. From the large angle made by the midrib of the pinnule with the rachis of the pinna the number of the pinnules on the frond seems crowded. In some of the pinnules the midrib has an elegant sigmoidal curve. This, with the parallel curvature of the lateral veins, gives a peculiar, exact, and elegant aspect to the plant.

The specimen figured was collected by Rev. Thomas Condon, at Currant Creek, Oregon, where it occurs matted together in masses. Lesquereux has also found what he considers to be the same species at John Day Valley, Oregon.

Of the described species, *Lastrea Fischeri* Heer (Fl. Tert. Helv. Vol. I, p. 34, Pl. IX, figs. 3a to 3e), resembles this most, but our plant is stronger, the pinnules are united for a greater portion of their length, are more acute, have a more crowded nervation and a distinctive upward curve. Yet these differences are rather of degree than kind, and hardly warrant the separation of the American and European plants.

From the species described by Lesquereux as *L. Goldiana* and *L. intermedia* (Tert. Fl., p. 56, Pl. IV, figs. 13 and 14), this may be distinguished by its acute, falcate, and more numerous pinnules.

Formation and locality: Tertiary (Miocene?). Currant Creek, Oregon.

Aspidium Kennerlyi Newb.

Pl. XVI, figs. 4, 5.

Boston Journ. Nat. Hist., Vol. VII (1863), p. 513.

"Frond pinnate; pinnæ deeply pinnatifid; pinnules oblong, obtuse, somewhat curved upward, united at their bases, margins acutely denticulate, sometimes entire; nervation strongly marked, secondary nerves mostly once-forked, basal nerve of each pinnule on the lower side often twice-forked."

This elegant species seems to have grown in the greatest abundance during the period of the deposition of the coal of Vancouvers Island, the shales over the Newcastle coal being so closely packed with its fronds as to show them crossing each other in every direction under every lamina that is raised. From their very abundance and consequent interference it is

impossible to obtain the entire outline of a frond, or even of a pinna; the frond must, however, have been of considerable size, and the pinnæ 8 or 10 inches in length. These last are linear in outline, some of them somewhat curved, others quite straight, the difference being doubtless due to their different positions in the frond. The pinnules are usually arched upward, very broad at the base, rounded or obtusely pointed at the summit. Where well preserved, the margins of the larger ones are seen to be finely but distinctly denticulate. The nervation is quite strong, but the frond was evidently thick and firm, and though very prominent on the under side, on the upper the nerves are scarcely visible. The midrib is slightly sinuous, and vanishes toward the summit of the pinnule. The secondary nerves are generally once-forked, but the upper ones are simple, and the lower one on the lower side is often twice-forked, or rather two once-forked nerves spring from the same base.

Among fossil species this may be compared with *A. Filix antiqua*, Al. Br. (Heer, Fl. Tert. Helv. Vol. I, p. 35, Pl. XI, fig. 1), but though crenulated the pinnules in that species are not denticulate, and they are not curved. The nerves are also less strong and more simple than in our plant.

Formation and locality: Cretaceous (Puget Sound group). Nanaimo, Vancouver Island.

Pecopteris (Cheilanthes) sepulta Newb.

Pl. LXII, figs. 5, 5a, 6.

Pecopteris (*Phegopteris*) *sepulta* Newb. Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 503.

"Frond small, delicate, pinnate; lower pinnæ straight, broadly linear in outline, rounded above, attached to rachis by the whole breadth of base; margins strongly lobed by the confluent pinnules; 1 centimeter wide by 5 centimeters long; upper pinnules crowded, conical in outline, gently curved upward, with waved or lobate margins; pinnules united by one-third of their length, oblong, obtuse; basal ones on lower side round, on the upper side flabellate, both attached by all their lower margin to the rachis of the frond; nervation strong and wavy, consisting of one many-branched nerve-stem in each pinnule, each branch once or twice forked; fructification unknown."

This elegant fern is apparently distinct from any species hitherto described. In general aspect it is not unlike *Pecopteris Torelli* Heer (Fl. Foss. Arct., Vol. I, p 88, Pl. I, figs. 15a, 15b), but in that species the pinnules are longer, more oblique, more acute, and the nervation more open. It also has some resemblance to *Cheilanthes Laharpii* Heer (Fl. Tert. Helv. Vol. I, p. 37, Pl. X, figs. 3a, 3b). That species is, however, more delicate, the pinnæ more widely separated, the pinnules to a less degree united, the basilar pair similar to the higher ones, the nervation more open.

The upper portion of the frond of this fern, where the pinnæ are not distinctly lobed, but simply undulate, bears a strong resemblance to that figured and described in Gardner and Ettingshausen's British Eocene Flora, Part II, p. 43, Pl. VI and Pl. X, figs. 2–4, under the name of *Gleichenia Hantonensis* (Wanklyn), but the secondary nerves are fewer and given off at a more acute angle.

The middle portion of the frond of our plant is, however, conspicuously different, since the pinnæ are deeply lobed, forming distinct and peculiar pinnules at the base instead of being confluent as in *G. Hantonensis*. It seems to be probable, however, that both ferns belong to the same genus.

What this genus should be called must remain a matter of doubt until specimens shall be obtained in which the fructification is shown. Without better evidence than we yet possess, the reference of our plant to Gleichenia seems to be unwarranted.

The general form of the frond and the nervation are more like those of some species of Cheilanthes than of any other living ferns with which this has been compared; but it will be necessary to have the fructification before the identification with that genus can be regarded as established. It has been thought better, therefore, to place it in the convenient receptacle afforded by the fossil genus Pecopteris, with a suggestion of its probable affinities in the living flora of the world.

The figures given represent, 5, the middle portion of the frond; 6, the upper part, and 5a, the lower two pinnules at base of pinna on the under side enlarged. They were collected by Dr. C. A. White, from the Green River shales.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Sphenopteris corrugata Newb.

Pl. I, fig. 6.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 10; Ills. Cret. and Tert. Pl. (1878), Pl. II, fig. 6.

Hymenophyllum cretaceum Lesq. Hayden's Ann. Rept., 1872 [1873], p. 421; Cret. Fl. (1883), p. 45, Pl. XXIX, fig. 6 [excl. Pl. I, figs. 3, 4].

"Form of frond unknown; pinnules ovate or cuneiform, narrowed at the base, obtuse, lobed, often plicated longitudinally; nerves distinct, dichotomously branching from the base.

"The specimens of this fossil collected by Dr. Hayden are fragmentary and imperfect, but quite sufficient to show it to be different from any described species."

Since the above was written Lesquereux has published in his Cretaceous Flora descriptions of a fern from the Dakota sandstones, at Fort Harker, which he calls *Hymenophyllum cretaceum.* Of this he gives several figures on Pl. I, and another on Pl. XXIX. Of these the latter certainly represents our species, which is easily recognized by the wedge-shaped subdivisions and the plicate or corrugated surface; but the specimens figured on Pl. I belong to a different species, of which the frond was membranous and the rachis winged, and which approached much nearer to the living *Hymenophyllum.*

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Order EQUISETACEÆ.

Equisetum Oregonense Newb.

Pl. LXV, fig. 7.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 503.

"Stem robust, 3 centimeters wide, longitudinal flutings numerous, about 24 in a half circumference; joints 5 centimeters distant; teeth triangular, short."

This species, collected by Rev. Thomas Condon, at Currant Creek, Oregon, is imperfectly represented in the collection, but there is enough of it to show it to be distinct from any other fossil yet found. It exceeds in magnitude any Tertiary species hitherto described in this country, and

approaches more nearly to the larger forms of the Mesozoic rocks. It may be compared with *E. robustum* Newb., this volume, page 15, Pl. XVI, figs. 1, 2, but the stem is broader, the flutings double the number, and the teeth much shorter and blunter than in that species. *E. procerum* Heer (Fl. Tert. Helv. Vol. III, p. 158, Pl. CXLVI, fig. 1), from Locle, Switzerland, is larger, but differs widely from it by its coarser fluting, long and furrowed teeth.

Formation and locality: Tertiary (Miocene?). Currant Creek, Oregon.

Equisetum robustum Newb.

Pl. XVI, figs. 1, 2.

Boston Journ. Nat. Hist., Vol. VII (1863), p. 513.

"Stem robust, 8 lines wide, with about 24 strongly marked furrows; sheaths long; teeth long-pointed, acute, as many as the furrows; internodes a little longer than the diameter of the stem."

There is no living species of Equisetum which attains the size of the fossil before us, though it does not rival in this respect those found in the older Mesozoic rocks. Between the living and older extinct species it seems to form a connecting link, a stepping-stone by which the Calamites of the coal period and the gigantic Equiseta of the Trias have come down to the humble dimensions of their present representatives.

There is no described Tertiary species with which it will be likely to be confounded. *E. procerum* Heer (Fl. Tert. Helv. Vol. III, p. 158, Pl. CXLVI, fig. 1), is even larger, but will at once be distinguished from it by its smoother stem and far more numerous and less acute teeth.

Formation and locality: Cretaceous (Puget Sound group). Bellingham Bay, Washington.

Equisetum Wyomingense Lesq.

Pl. LXV, fig. 8.

Hayden's Ann. Rept., 1873 [1874], p. 409; Tert. Fl. (1878), p. 69, Pl. VI, figs. 8–11.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Note.—So identified by Dr. Newberry, as indicated by memorandum on plate and label on specimen, but further information lacking.—A. H.

Equisetum sp.? Newb.

Pl. XXII, figs. 3, 4.

Fig. 3. "Radicle tubers of Equisetum (not described)." Ills. Cret. and Tert. Pl. (1878), Pl. VII, fig. 4.

Fig. 4. "Root of some ligneous plant (not described)." Ills. Cret. and Tert. Pl. (1878), Pl. VII, fig. 3.

Note.—The only manuscript by Professor Newberry which I have been able to find is a penciled memorandum on the plate referring these to Equisetum, viz:

Fig. 3. "Tuberous roots of Equisetum sp.?"

Fig. 4. "Aquatic rootlets of Equisetum sp.?"

Fig. 3 certainly represents *E. globulosum* Lesq., Proc. U. S. Nat. Mus., Vol. V (September 29, 1882), p. 444, Pl. VI, figs. 1, 2; Cret. and Tert. Fl. (1883), p. 222, Pl. XLVIII, fig. 3; but there is no indication that Dr. Newberry intended so to refer it.—A. H.

PHANEROGAMIA.

GYMNOSPERMÆ.

Order CYCADACEÆ.

Nilssonia Gibbsii (Newb.) Hollick.

Pl. XV, figs. 2, 2a.

Tæniopteris Gibbsii Newb., Boston Journ. Nat. Hist., Vol. VII (1863), p. 512.
Nilssonia Johnstrupi Heer, Fl. Foss. Arct., Vol. VI, Abth. II (1882), p. 44, Pl. VI, figs. 1–6.

"Frond simple, petiolate, oblong, elliptical in outline, rounded at base and summit; margins entire, midrib strong, straight, smooth; lateral nerves leaving the midrib nearly at a right angle, simple, fine, parallel, numerous."

The above description was based on a single specimen collected by Mr. George Gibbs from the Cretaceous strata on Orcas Island, Washington, in 1858. From the character of the nervation and the entire margins it was supposed to be a fern, but Professor Heer has since obtained a number of specimens of the same plant from the Upper Cretaceous strata of Greenland, which seem to prove that it is the leaf of a cycad. (Fl. Foss. Arct., VI, Abth. II (1882), p. 44, Pl. VI, figs. 1–6.) He has named his plant *Nilssonia Johnstrupi*, but the specific name given by me has priority.

It is far more interesting to identify a plant from Orcas Island with one found in the Cretaceous strata of Greenland than to find it to be a new genus or species, as it helps us to establish a geological parallelism, and shows the wide diffusion of some species through the Cretaceous strata. By this plant and a few others the Vancouver and Orcas Island beds are connected with those of Atane, Greenland, and many common species correlate the Atane beds with the Amboy Clays of New Jersey.

Formation and locality: Cretaceous (Puget Sound group). Point Doughty, Orcas Island, Washington.

Order CONIFERÆ.

Araucaria spatulata Newb.

Pl. I, Figs 5, 5a.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 10; Ills. Cret. and Tert. Pl. (1878) Pl. II, figs. 5, 5a.

"The only specimen of this beautiful species contained in the collections of Dr. Hayden is a fragment of a branch, nearly half an inch in diameter. On this the leaves are thickly set, their bases slightly decurrent, being scarcely separated from each other. From these bases the leaves radiate in all directions, and are slightly recurved. They are half an inch in length, broadly spatulate, obtuse, and narrowed at the base. Along the medial line passes a distinct carina, which vanishes toward the apex."

From all living or fossil species, this seems very clearly distinguished by the form of the leaves. Two species of Araucarites have been described from the Cretaceous formation, of which descriptions are before me: *A. acutifolius* Endl. and *A. crassifolius* Endl. (Synops. Conif., pp. 301, 302), neither of which has spatulate leaves.

There is little doubt that this was a true Araucaria, and not very unlike, in its general aspects, some species now living.

It is also probable that these trees formed extensive forests on the land during the Cretaceous period, as I have found these strata in some localities in the West literally filled with large trunks of coniferous trees, many

of which have rather the structure of Araucaria than of Pinus, Abies, or Juniperus, although all these genera were represented at that epoch.

Formation and locality: Cretaceous (Dakota group). Sage Creek, Nebraska.

ABIETITES CRETACEA Newb. n. sp.

Pl. XIV, fig. 5.

NOTE.—The only manuscript by Dr. Newberry in regard to this figure is on the label attached to the specimen.

The following description has been prepared from an examination of the specimen:

Branchlet slender; leaves one-half inch long, crowded, short petiolate, narrowly ovate-lanceolate, attenuate at both ends.—A. H.

Formation and locality: Cretaceous (Dakota group). Whetstone Creek, Santa Fe trail, northeastern New Mexico.

SEQUOIA CUNEATA Newb.[1]

Pl. XIV, figs. 3–4a.

Taxodium cuneatum Newb. Boston Journ. Nat. Hist., Vol. VII (1863), p. 517.

"Leaves numerous, short, broad, spatulate in form, rounder or subacute at summit, wedge-shaped below, narrowed into a very short petiole, or sessile upon the branchlets."

The specimens of this plant contained in the collection, though numerous, are too imperfect for satisfactory description. If found in strata of the same age, it might be considered but a variety of Taxodium; but if we can trust the accuracy of the very intelligent gentleman by whom it was collected, it is clearly of Cretaceous age, and therefore, in all probability, quite distinct from any described species.

The spatulate or cuneate form of the leaves, if this should be found to be a constant character, would serve to distinguish it at a glance from its Tertiary representatives.

Formation and locality: Cretaceous (Puget Sound group). Nanaimo, Vancouver Island.

[1] This species was transferred by Dr. Newberry from Taxodium to Sequoia in his manuscript.—A. H.

Sequoia gracillima (Lesq.) Newb.

Pl. XIV, fig. 6; XXVI, fig. 9.?

Glyptostrobus gracillimus Lesq. Am. Journ. Sci., Vol. XLVI (July, 1868), p. 92; Cret. Fl. (1874), p. 52, Pl. I, figs. 8, 11–11f.
"Cone of *Sequoia* (not described)." Ills. Cret. and Tert. Pl. (1878), Pl. XI, fig. 9.

Lesquereux described (loc. cit.) a conifer which occurs frequently in the Dakota group in Nebraska, and also in the Cretaceous strata of New Jersey. It is characterized by a great number of slender, almost filiform, branches covered with acute lanceolate or ovate, sometimes subulate, leaves. Lesquereux speaks of their occurring in whorls of three, but in the large number of specimens before me I can find no evidence of a verticillate arrangement, and they seem to surround the stems spirally. They differ considerably in length, but the foliage can hardly be said to be dimorphous as in Glyptostrobus, Sequoia, and many other conifers, but usually on the older branches they are more closely appressed, more spreading above. Lesquereux compares this plant with Frenela of Australia, and suggests that it may be identical with Ettingshausen's *Frenelites Reichii*, from the chalk of Niederschœna. It has been my good fortune to obtain a number of cones of this plant, both from Nebraska and New Jersey, and I am able, therefore, to give a more complete description of it than has been heretofore possible. The cones are cylindrical, 2 to 2½ inches in length, one-half inch in diameter, and are formed of relatively large peltate scales, each with an umbilicus and central tubercle. [See Pl. XXVI, fig. 9.?] This is a totally different cone from that of Glyptostrobus, in which the divisions are squamiform with a fanlike, crenulated margin. The form of scale in the cones before us is similar to that of Sequoia and Taxodium, but the cones of the latter are usually globular, while those of Sequoia are often elongated, sometimes subcylindrical. The character of the foliage is near to that of some of the Sequoias, *S gigantea* and *S. Couttsiæ*, for example, while in Glyptostrobus the two forms of foliage are much more distinctly marked, the short appressed leaves closely investing the branches, resembling those before us, the open foliage quite different. The foliage of this plant is found in considerable abundance in the sandy layers of the Cretaceous on the Raritan River, and the cones were formerly numerous in the clay beds at Keyport, where they were associated with great quantities of lignite, very

probably produced by the trees on which they were borne. In some cases the cones were replaced by pyrites, and these represent the original form and markings very perfectly, but require to be kept in alcohol or naphtha to prevent oxidation. They will be found in my memoir on the Flora of the Amboy Clays.

Formation and locality: Cretaceous (Dakota group). Whetstone Creek, New Mexico. (Excluding fig. 9.)

NOTE.—In the discussion of this species Dr. Newberry mentions having obtained cones from Nebraska and describes them, but does not refer to fig. 9, Pl. XXVI, which is therefore questioned by me.—A. H.

SEQUOIA HEERII Lesq.

Pl. XLVII, fig. 7.

Hayden's Ann. Rept., 1871 [1872], p. 290; Tert. Fl. (1878), p. 77, Pl. VII, figs. 11–13.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon

NOTE.—The only reference by Dr. Newberry to this figure which I have been able to find is a pencil memorandum of the name, on the plate, and the specimen label giving the locality.—A. H.

SEQUOIA NORDENSKIOLDII Heer?.

Pl. XXVI, fig. 4.

Fl. Foss. Arct., Vol. II (Miocene Fl. u. Fau. Spitzbergens, 1870), p. 36, Pl. II, fig. 13b; IV, figs. 1a, 1b, and 4–38.

Taxites Langsdorfii Brong. ? Prod. (1828), p. 108.

Sequoia Langsdorfii (Brong.) Heer. Fl. Tert. Helv., Vol. I (1855), p. 54, Pl. XX, fig. 2; XXI, fig. 4.

"*Sequoia Langsdorfii* ? Br." Newberry, Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 46; Ills. Cret. and Tert. Pl. (1878), Pl. XI, fig. 4.

The leaves here figured are part of a large number of the same species collected by Dr. Hayden on the banks of the Yellowstone River. They are contained in fragments of a shaly argillaceous limestone, which have their surfaces covered by disconnected twigs with their leaves attached, that present the appearance of having been thrown down together, precisely as the deciduous branchlets of our cypress are detached by the frost. Among these are a few pieces of larger branches bearing short appressed leaves, which I have conjectured to be the permanent foliage of the tree.

These branches show at regular intervals the former points of attachment of deciduous (?) branchlets, but more of these are still in their places. They may have been dead twigs, some of which would naturally fall and accumulate with the leaves. The leaf-bearing branchlets are simple, and though lying together in great numbers and crossing at every angle, are distinct and disconnected. The probability would therefore seem to be that the foliage of the tree was deciduous, and although we have as yet no fruit to guide us, we may infer that it was not a Sequoia, but a Taxodium allied to our deciduous cypress. The leaves on the permanent branches are many-rowed, short, appressed, and awl-shaped. Those on the deciduous (?) branchlets are two-ranked, much longer, linear, acute or rounded, traversed by a strong median nerve, and decurrent at the base. The lower leaves on the branchlets are also generally shorter, sometimes much shorter, than those placed higher up.

In my notes on these specimens, given in The Later Extinct Floras, written before the publication of Professor Heer's series of works on the arctic flora, these specimens were doubtfully referred to *Sequoia Langsdorfii*, to which they bear a considerable resemblance, but the foliage seems to have been more open and the leaves more decidedly decurrent. In these characters they approach very closely to the foliage of *Sequoia Nordenskioldii*, of which the description is published in the Fl. Foss. Arct., Vol. II, Abth. III, Miocene Flora und Fauna Spitzbergens, p. 36, Pl. IV, figs. 4–38. The correspondence is so close that I have been led to regard them as probably identical. More material, including the fruit, will be necessary to discriminate between these closely resembling conifers, and this reference, which seems authorized by the character of the foliage, must be considered as provisional until confirmed by evidence which is more conclusive.

Formation and locality: Tertiary (Eocene ?). Yellowstone River, Montana.

Sequoia spinosa Newb.

Pl. LIII, figs. 4, 5.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 504.

"Branches slender; foliage open, rigid; leaves narrow, acute (acicular) arched upward, appressed or spreading; spirally divergent; staminate

flowers in slender terminal aments, 2 inches long, 2 lines wide, anthers few, under peltate connective scales; cones ovate or subcylindrical, composed of rhomboidal or square peltate scales."

We have in the specimens before us, collected by Captain Howard, U. S. N., a new and strongly marked species of Sequoia, which is distinguishable at a glance from all of its known congeners by its remarkably sparse, rigid, slender, and acute leaves. As usual among conifers of this group, there is some diversity in the character of the foliage, some of the leaves being closely appressed, others longer and more spreading. In general aspect the terminal branchlets resemble some of those belonging to *S. Couttsiæ* Heer (Phil. Trans., Vol. CLII, Pt. II; Foss. Fl. Bovey Tracey, Pl. LX, figs. 1, 2, 3, 6, 15, 44, 45; Fl. Foss. Arct., Vol. I, Pl. XLV, fig 19), but the leaves are longer and more slender. None have been observed taking the squamose form exhibited by most of the foliage of *S. Couttsiæ* in the illustrations given by Professor Heer. The cones, too, are longer, being subcylindrical, while in *S. Couttsiæ* they are nearly globular. One of the cones is represented in fig. 5, Pl. LIII, unfortunately rather badly preserved. Quite a number are associated with the leaves in the specimens before us, but none more complete. The sterile aments are slender, the group of anthers much less crowded than usual. On some of the branchlets the foliage is more crowded and the leaves are broader than in the specimens figured on Pl. LIII, but this may be considered as a fair representation of its average character.

Formation and locality: Tertiary (Miocene). Cook Inlet, Alaska.

Taxodium distichum miocenum Heer.

Pl. XLVII, fig. 6; LI, fig. 3, in part; LII, figs. 2, 3 and 4 in part; LV, fig. 5, in part.
Miocene Baltische Flora (1869), p. 18, Pl. II; III, figs. 6, 7.

Formation and locality: Tertiary (Miocene). Birch Bay, Washington (Wilkes Exploring Expedition).

Note.—In the discussion of *T. occidentale* Dr. Newberry says that the specimens obtained at Birch Bay, Washington, by Professor Dana, and at Currant Creek, Oregon, by Rev. Thomas Condon, are hardly to be distinguished from the living *T. distichum*.—A. H.

Taxodium occidentale Newb.

Pl. XXVI, figs. 1–3; LV, fig. 5, in part.?

Boston Journ. Nat. Hist., Vol. VII (1863), p. 576; Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 45; Ills. Cret. and Tert. Pl. (1878), Pl. XI, figs. 1–3.

"Branchlets terete, leaves numerous, crowded, generally opposite, sessile, or very short petioled, one-nerved, flat, rounded at both ends."

Branchlets terete, leaves distichous, sessile on very short petioles; one-nerved, flat, rounded at both ends, the larger ones 4 centimeters wide by 20 centimeters long, the shorter ones elliptical, scarcely longer than wide.[1]

The characters and variations of the foliage of this plant are very well shown in the figures given of it. From these it will be seen that the leaves are unusually broad for their length, are distinctly rounded at both ends, are sessile or very short petioled, and are not at all decurrent. Some of them are also very short, the shortest almost circular, and they are borne on the secondary as well as tertiary branchlets.

In the notice of these leaves in The Later Extinct Floras they were compared with those of *Taxodium dubium* Heer, and it was stated that it differed from that species in having a larger number of leaves, less obliquely set on the branches, with rounded extremities, whereas in the foreign species the leaves are lanceolate in outline and acute at both ends. In his later works Professor Heer has expressed the opinion that *Taxodium dubium* is only a form of *T. distichum*, now living in our Southern States. This view has been generally accepted by fossil botanists, and the plants under consideration must be compared with the deciduous cypress. In looking over the large number of specimens which I have received from various localities I find that many of them can not be distinguished from the leaves of the living cypress. This is true of collections made by Professor Dana at Birch Bay, by Rev. Thomas Condon at Currant Creek, Oregon, and by Dr. Hayden in the lignite Tertiaries of the upper Missouri River. The specimens now figured, however, obtained by Dr. Hayden on the Yellowstone and Dr. Cooper in northern Montana, exhibit characters which would seem to be sufficient to separate them from the deciduous cypress, the leaves being relatively much broader and rounded at both ends.

[1] In addition to the original published description, as quoted, the above subsequent manuscript description is also included.—A. H.

Formation and locality: Tertiary (Eocene?). Yellowstone River, Montana and northern Montana. (Excluding Pl. LV, fig. 5, in part,.)

Glyptostrobus Europæus (Brong.) Heer.

Pl. XXVI, figs. 6–8a; LV, figs. 3, 4.[1]

Fl. Tert. Helv., Vol. I (1855), p. 51, Pl. XIX; XX, fig. 1.
Taxodium Europœum Brong. Ann. Sci. Nat., Vol. XXX (1833), p. 168.
"*Glyptostrobus Europœus* (Brong.)." Newberry, Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 43; Ills. Cret. and Tert. Pl. (1878), Pl. XI, figs. 6–8a.

"Branches slender, bearing many branchlets; leaves of two forms, one short, thick, and appressed, the other longer (one-half inch), slender, divergent, acute, the shorter form carinated, the longer less distinctly, if ever so; male catkins small, terminal, globular, composed of a few shield-shaped scales; fertile cones larger, ovoid in form, scales narrow, wedge-shaped at base, at summit expanded, semicircular, with waved or crenate margins, the dorsum of each more or less distinctly marked with 10 to 12 acute, radiating carinæ."

One of the most interesting plants of the European Tertiary is the Glyptostrobus, first discovered by Brongniart, and subsequently fully illustrated in the magnificent work of Prof. O. Heer, Flora Tertiaria Helvetiæ, Vol. I, p. 52, Pl. XVIII; XXI, fig. 1; Vol. III, p. 159. The genus is now only represented on the earth's surface by *G. heterophyllus* and *G. pendulus* of China, but during the middle Tertiary epoch was widely spread over both hemispheres. Most of the exposures of our older Tertiary strata have furnished specimens of some one of the various phases of what is regarded by Professor Heer as a single species, but which has been described under the three names of *G. Europœus*, *G. Ungeri*, and *G. Oeningensis*

What are probably but varieties of this same plant were collected by the United States Exploring Expedition under Captain Wilkes, at Birch Bay, Washington, by George Gibbs, esq., geologist to the Northwestern Boundary Commission (see Boston Journ. Nat. Hist., Vol. VII, No 4 (1863), p. 517), and are represented by numerous specimens in the collection of fossil plants made by Dr. Hayden on the Yellowstone and Upper Missouri.

[1] Dr. Newberry's only manuscript for Pl. LV, figs. 3, 4, is a pencil memorandum referring them to "*Glyptostrobus Ungeri* Heer."—A. H.

In this country, as in Europe, the foliage of Glyptostrobus exhibits two forms wherever the plant is found; the short appressed, and the longer divergent leaves. In addition to this the specimens from the northwest coast have common character by which they may be distinguished at once from those collected by Dr. Hayden. The Western plant is more slender, the appressed leaves sharper and more delicate, the divergent leaves much longer, corresponding more nearly to the European form described as *G. Ungeri*, while those from the Upper Missouri resemble more the variety known as *G. Europæus*. The cones, however, found with the Missouri specimens are more like those of *G. Ungeri* than *G. Europæus*, the dorsum of the scale being marked by short, radiating carinæ, as in the former, the margin being waved, but not regularly scalloped, as in the latter.

From the extreme West we have as yet no cones which can be certainly referred to this plant, so that the most important element in the comparison is wanting, but it would seem that here, as in Europe, the different phases of the plant belonging to the genus Glyptostrobus are so linked together that they should be regarded as forming but a single species. At least we have not yet obtained sufficient material to justify us in attempting to define the limits of other species.

The two living species of Glyptostrobus which Fortune found growing in China seem to resemble the fossil forms as much as they do each other, and it is perhaps doubtful whether they should not all be united under the same name. The living and fossil plants are associated with fan-palms, and belong to the flora of the southern temperate zone, or that of a latitude ten degrees south of the localities where the fossils occur.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota, and Birch Bay, Washington (Wilkes Exploring Expedition).

Thuja interrupta Newb.

Pl. XXVI, figs. 5–5d.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 42; Ills. Cret. and Tert. Pl. (1878), Pl. XI, figs. 5, 5a.

"Branchlets flat, narrow, linear, pinnate, opposite, except at the summit of the branch, somewhat remote, connected only by the slender woody axis on which the leaves of the branchlets are not decurrent; leaves in four

rows appressed, those of the upper and lower ranks orbicular or obovate, shortly mucronate, lateral ones longer, subulate, terminating in awnlike points; larger branches naked or bearing closely appressed linear scalelike leaves."

This is a very distinct and beautiful species collected by Dr. Hayden, near Fort Union, Dakota, presenting marked differences from any known living or fossil members of the genus.

Its most remarkable character is its slender and graceful habit, and the separation of the pairs of leafy branchlets along the naked and slender branch. The leaves, too, are less crowded than in most other species, and the lateral ranks are prolonged into acute awnlike points, all of which must have given it an aspect considerably unlike that of any species hitherto described.

At the time this species was described no true Thuja had been recognized in the fossil state. *Thuites salicornoides* (Ung. Chlor. Prot. Pl. II, fig. 1; XX, fig. 8) is regarded by Endlicher and Heer as a Libocedrus, to which it certainly seems, judging from the figures and descriptions given of it, to be more closely allied than to Thuja. Since that time, however, a number of fossil plants have been referred to the genus Thuja, principally derived from the amber. One species, *T. saviana*, Gaud., Neue Denkschr. Schweitz. Gesell., Vol. XVII (1860) Fl. Foss. Ital., 3d Memoir, p. 12, Pl. I, figs. 4–20; II, figs. 6, 7, has been established upon the fruits as well as the foliage, so that there can be no question in regard to its botanical position. Another species, *T. mengeanus*, Goepp. and Ber. Monogr. Foss. Conif. (1850), p. 181, Pl. XVIII, figs. 10, 11, resembles so closely our *T. occidentalis* that it has been referred by Goeppert to that species. Besides this, half a dozen additional species obtained from the amber have been described by Goeppert from meager material and consequently somewhat vaguely. It may be considered established, however, that during the Tertiary age the genus Thuja was in existence and well represented in the coniferous flora. The species now under consideration is represented by a large number of specimens, though usually of small size, in the collections made at Fort Union by Dr. Hayden, and has also been met with by Mr. George M. Dawson in the Tertiary lignite strata of Canada. No fruit has been found that can be certainly connected with the leaves, but there is in the collection one imperfect cone derived from the same locality with the

branches of Thuja which resembles closely in structure the cone of *T. occidentalis.*

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

ANGIOSPERMÆ.

MONOCOTYLEDONEÆ.

Order GRAMINEÆ.

PHRAGMITES sp.? Newb.

Pl. XXII, figs. 5, 5a.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 38; Ills. Cret. and Tert. Pl. (1878), Pl. VII, figs. 5, 5a.

"Among the plants collected by Dr. Hayden from the Miocene beds near Fort Union are numerous fragments of what seems to be a species of Phragmites. These consist of portions of broad, unkeeled, flaglike leaves, marked by numerous longitudinal nerves, of which there are eight or nine more strongly marked, and between these about seven much finer, connected by alternate cross bars. No keel is shown in any of these fragments. In general structure these leaves closely resemble those of *P. Oeningensis* Heer (Fl. Tert. Helv., Vol. I, p. 64, Pl. XXIV); but the material is not sufficient to determine whether our species is identical with that.

"*Formation and locality:* Fort Union, Dakota (Dr. Hayden)."

Order PALMÆ.

SABAL CAMPBELLI Newb.

Pl. XXI, figs. 1, 2.

Boston Journ. Nat. Hist., Vol. VII (1863), p. 515.

"Leaf large, 8 feet in diameter, with fifty to seventy folds; petiole long, 16 lines or more in width, flat above, without a central keel and unarmed; nerves numerous and fine, about fifty in each fold—six principal nerves on each side of the midrib, with three intermediate nerves between each pair, the middle one being strongest."

In its general character this palm bears a strong resemblance to *Sabal major*, Ung. sp. (Chlor Prot., p. 42, Pl. XIV, fig. 2; Fl. Tert. Helv., Vol. I,

p. 88, Pl. XXXV; XXXVI, figs. 1, 2), the size of the leaf, the number of folds, and the character of the nervation being nearly the same; but in our plant the petiole is flat or slightly arched, without the central keel of *S. major* Unfortunately we have as yet obtained no specimen showing the under side of the leaf, and therefore want the important diagnostic character of the length of the point of the petiole.

From *Sabal Lamanonis* this species may be distinguished by its greater size, more numerous leaf-folds, finer and more crowded nervation, and by its flat unkeeled petiole.

Fan-palms are not now found on the Pacific coast above Cape St. Lucas (lat. 23° north), though the average temperature would permit them to grow perhaps as far north as San Francisco (lat. 38°). In the valley of the Mississippi and on the Atlantic coast they extend northward to the parallel of 35°.

Formation and locality: Cretaceous (Puget Sound group). Bellingham Bay, Washington.

SABAL GRANDIFOLIA Newb. n. sp.

Pl. XXV; LXIII, fig. 5; LXIV, figs. 2, 2a.

Sabal Campbelli Newb. (in part). Boston Journ. Nat. Hist., Vol. VII (1863), p. 515.
"*Sabal Campbelli* Newb." Ills. Cret. and Tert. Pl. (1878), Pl. X.

Leaves very large, 8 to 10 feet in diameter, with eighty to ninety folds; petiole 1½ to 3 inches wide, flat or slightly arched above without a keel above or below; margins smooth, terminating in an arch, often unsymmetrical, on the upper side, from which the folds radiate; on the under side prolonged into a spine, 6 inches or more in length.

This species was first made known by specimens brought by Dr. Hayden from the valley of the Yellowstone. These represent both the under and upper surfaces of the leaf, and among them are fragments from the central and marginal portions. Some of these specimens are the originals of the figures given on Pls. XXV and LXIV. A portion of a leaf supposed to belong to this species is represented in Pl. LXIII, fig. 5. This was from Fischers Peak, New Mexico.

In the great number of the remains of palms found in the Tertiary and Cretaceous rocks of the west—trunks, leaves, and fruit—it has been very difficult to define distinct species, and it is probable that many years will

elapse before perfect order can be brought out of the present confusion. The species now under consideration may, however, be identified by the large size of its leaf, its plain unkeeled petiole drawn out into a long acute spine on the under side, the very numerous folds, and the crowded, subequal nervation.

The only species that rivals it in size and is liable to be confounded with it is *Sabalites Grayanus* Lesq. (Tert. Fl., p. 112, Pl. XII, fig. 2), reported as found at "Golden, Colorado; Point of Rocks, Wyoming; Vancouver Island, and in Mississippi." Only fragments have, however, been found in some of these localities, and it is scarcely probable that their identification with the specimens from Golden will be confirmed by future observation. In the figure given by Lesquereux of the type of his species, the point of the petiole is not more than half as long as in some of the leaves of *Sabal grandifolia;* and if the strongly keeled petiole, of which a portion is represented on the plate cited above, can be accepted as normal for *S. Grayanus*, this would in itself be sufficient to distinguish the species. The petiole of the leaf of *S. grandifolia* is smooth and gently arched above and below, never keeled.

I formerly supposed this species to be identical with that found at Bellingham Bay, Washington (*S. Campbelli*, Newb.), and figured on Pl. XXI of this monograph, but that species has somewhat smaller leaves, with a less number of folds and less crowded nervation.

The best specimens yet obtained of *Sabal grandifolia* are those collected by Dr. Hayden in the Yellowstone Valley; but others, which indicate an almost equal size and exhibit essentially the same characters, were obtained by Mr. I. C. Russell from the green sandstones of the Laramie group on Fischers Peak, Colorado, and I have specimens representing this species from Walsenburg, Florence, Coal Basin, and other places where there are outcrops of the Laramie. Fan-palms occur in the Cretaceous rocks of Orcas Island and in the coal series of Fletts Creek, near Tacoma, Washington, but they are smaller and with fewer folds. Fragments of palm leaves were obtained by Dr. Evans on Vancouvers Island, and these have been referred to *Sabalites Grayanus* by Lesquereux, but they were very imperfect and of little value in the comparison of species.

Formation and locality: Cretaceous (Laramie group). Fischers Peak, Colorado, and Tertiary (Eocene?), Yellowstone River, Montana.

Sabal imperialis Dn.

Pl. XVI, figs. 6, 6a.

Trans. Roy. Soc. Canada, Vol. I, Sec. IV, 1882 [1883], p. 26, Pl. VI; Vol. XI, Sec. IV, 1893 [1894], p. 57, Pl. XIV, fig. 61.
Sabal sp. Newb. Boston Journ. Nat. Hist., Vol. VII (1863), p. 515.

"Fragments only of a fan palm are contained in the collections made at Nanaimo; if, as now appears probable, the beds containing it are Cretaceous, it will doubtless prove to be a new species.

"The only tangible characters exhibited in the specimens yet obtained are in the nervation.

"The nerves are very fine, nearly sixty in each fold—six stronger ones on each side of the midrib, and between each two of these three finer ones, of which the middle is strongest."

Formation and locality: Cretaceous (Puget Sound group). Nanaimo, Vancouvers Island.

Sabal Powellii Newb.

Pl. LXIII, fig. 6; LXIV, figs. 1, 1a.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 504.

"Leaves of medium size, 4 or 5 feet in diameter, petiole smooth, unarmed, terminating above in a rounded or angular area from which the folds diverge, beneath concavely narrowing to form a spike 3 to 4 inches in length; rays about fifty, radiating from the end of the petiole, perhaps sixty in the entire leaf compressed to acute wedges where they issue from the petiole; strongly angled and attaining a maximum width of about 1 inch; nerves fine, about twelve stronger ones on each side of the keel, with finer intermediate ones too obscure for enumeration."

These leaves, as will be seen by the figures given, bear considerable resemblance to those described by Lesquereux under the name of *Flabellaria Eocenica* (Tert. Fl., p. 111, Pl. XIII, figs. 1–3), but a large number of specimens in the collections made at Green River, agreeing among themselves in all essential particulars, enable us to clearly define the species and show its distinctness from any yet found on this continent. From *Flabellaria Eocenica* it differs in having a larger number of folds and a longer point of support on the under side of the leaf. From *Sabal Campbelli* Newb.

it may be distinguished by its smaller size, less number of folds, and somewhat shorter spike of the petiole. *Sabal Grayanus* Lesq., is larger, with nearly double the amount of rays and a keeled petiole. *Sabal grandifolia* Newb. is much larger and like *S. Grayanus* has twice as many folds. These large species may be distinguished from each other by the concavely pointed and keeled petiole of *S. Grayanus*.

In the figures given, that on Pl. LXIII, fig. 6, represents the under side of the leaf at its base, showing pointed spike formed by the prolongation of the petiole. Pl. LXIV, fig. 1, represents the summit of the petiole and base of the leaf on the upper side. Here the rays are inserted on either side of a nearly symmetrical angle of the petiole, but other specimens show that the line of insertion of the rays is sometimes obliquely arched, precisely as in the figure of the base of the leaf of *Sabal grandifolia*, shown in fig. 2, Pl. LXIV. Fig. 1a of the same plate represents two folds of the leaf of *Sabal Powelli*, given of the natural size, to show the nervation.

Formation and locality: Tertiary (Green River group). Green River Station, Wyoming.

Manicaria Haydenii Newb.

Pl. LXIV, fig. 3.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 504.

"Frond large, leaves pinnately plicated, folds 1½ centimeters in width above, slightly narrowed below; flat or gently arched, smooth, springing from the midrib at an angle of 25 degrees above, 30 degrees below (in the specimens figured); folds attached to the midrib obliquely by the entire width, and to each other by their entire length (?); nervation fine, uniform (?), parallel."

The specimen figured is only a small portion of an entire leaf, and is inadequate to supply material for a satisfactory description. It is, however, evidently the central portion of a palm leaf of which the general form was elongated and the length probably many times the breadth. It was composed of a large number of pinnate, united, flattened folds, divergent from the midrib at an acute angle. These folds were not keeled like those of Flabellaria and Sabal, but either plain or gently arched; whether they were united throughout their entire length or were free toward the margin of the leaf is not certainly known, as we have nowhere seen the entire breadth of

the leaf; but it is probable that they were joined to the margin. Until more complete specimens of this plant shall be obtained nothing positive can be said of its relations to living palms; but it is evidently allied to Heer's *Manicaria formosa* (Fl. Tert. Helv. I, p. 92, Pl. XXXVIII), and to the living Manicaria of South America. It certainly also belongs to the same genus with Lesquereux's palm leaves which he has grouped under the new generic name of Geonomites, but it has seemed to the writer more closely allied to Manicaria than Geonoma. Its specific relations are also somewhat doubtful. It most resembles *Geonomites tenuirachis* Lesq. (Tert. Fl., p. 117, Pl. XI, fig. 1), but in the figured specimen of that plant the folds of the leaf spring from the midrib at a much more acute angle than in the specimen before us. This difference could be reconciled if it were certain that Lesquereux's specimens came from near the summit of the leaf, where the folds generally approach the direction of the midrib. Dr. Hayden reports the specimen to which the name of *Geonomites tenuirachis* was given as coming from the Raton Mountains and from strata which are older than that which furnishes the specimen now described. So far as now known there are no species common to the Raton Mountain beds and the Green River Tertiary. There is a strong probability, therefore, that the differences indicated have specific value.

Formation and locality: Tertiary (Green River group). Green River Station, Wyoming.

Order SMILACEÆ.

Smilax cyclophylla Newb.

Pl. LIV, fig. 3, in part.

Boston Journ. Nat. Hist., Vol. VII (1863), p. 520.

"Leaves circular or round, ovate, cordate or slightly peltate at base, five-nerved, central and interior pair of lateral nerves strongly marked, basilar pair delicate and scarcely reaching the middle of the leaf; secondary nervation forming a polygonal network more or less rectangular."

Unfortunately, the only specimen of this plant which I have—that collected by Professor Dana and figured in his Geology of the United States Exploring Expedition, Atlas, Pl. XXI, fig. 10—is imperfect, the upper part of the leaf being wanting. So far as its outline is indicated by the part which remains, it would seem to have been nearly orbicular. If

such was the case, it resembled in general aspect the leaves of *S. orbicularis* Heer (Fl. Tert. Helv., Vol. III, p. 167, Pl. CXLVII, figs. 18, 19), and perhaps as much those of the living *S. rotundifolia.*

From *S. orbicularis* it differs, however, in the shortness of the exterior pair of lateral nerves and in the polygonal reticulation of the secondary nervation.

Formation and locality: Tertiary (Eocene?). Birch Bay, Washington.

Order IRIDACEÆ.

IRIS sp.? Newb.

Pl. XXII, fig. 6.

Ills. Cret. and Tert. Pl. (1878), Pl. VII, fig. 6.

NOTE.—The only manuscript relating to this specimen which I have been able to find is the above designation, in pencil, on the margin of the plate. Locality not known.—A. H.

MONOCOTYLEDON OF UNCERTAIN AFFINITIES.

MONOCOTYLEDON gen. et sp.? Hollick.

Pl. XLVI, fig. 9.

NOTE.—This figure apparently represents the lower portion of a leaf of some monocotyledon, but neither the specimen nor any manuscript referring to it was found except a memorandum of the locality on the plate margin, and there is no indication of Dr. Newberry's ideas concerning its affinities.—A. H.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

DICOTYLEDONEÆ.

Order JUGLANDACEÆ.

JUGLANS NIGELLA Heer.

Pl. LI, figs. 2 (in part), 4.

Fl. Foss. Arct., Vol. II, Abth., II (1869); p. 38, Pl. IX, figs. 2–4.

NOTE.—So identified by Dr. Newberry, as indicated by memorandum on margin of plate.—A. H.

Formation and locality: Tertiary (Miocene). Admiralty Inlet, Alaska.

Juglans occidentalis Newb.

Pl. LXV, fig. 1; LXVI, figs. 1–4c.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 507.

"Leaves somewhat variable in form and size, from 3 to 8 inches in length and 1 to 2 inches in width, but generally 6 inches long by 1½ inches wide, broad-lanceolate in outline, widest in the middle, summit acute, base rounded, often unsymmetrical; margins entire; nervation delicate; midrib straight; lateral nerves, about twenty on each side, gently curved upward, the lower ones branched and anastomosing near their extremities, the upper simple and terminating in the margins; tertiary nervation very delicate, or obscure from being buried in the parenchyma of the leaf, forming an open and irregular network. Fruit small, elongated, somewhat prismatic; divisions of the envelope lenticular in outline, narrow, thin."

The figures given of this species, collected by Dr. C. A. White, illustrate very well the average size and form of the leaves. The number contained in the collection is large, and they seem to have been extremely abundant in the locality where they were obtained. In a few instances they are found attached to the stems that bore them, but are generally separated and more or less torn and broken. The tree was evidently a strong-growing and luxuriant one, for some of the leaves are not less than 8 inches in length; the nervation is fine and often not discernible, probably from the thickness of the leaf; in some specimens, however, it is more distinct and has all the characters of that of the genus to which the leaves have been referred. The fruit, of which fortunately one specimen was found in immediate contact with the leaves, is small, marked with raised lines, elongate in form, and resembles more the fruit of *Carya olivæformis* than any other of our living species. It might be inferred from the small size of the nut and its elongated form that it was immature, but near it lies a segment of the envelope which has apparently exfoliated at maturity. As only one specimen of the fruit has been discovered, it is possible that it does not represent the average size and form. This fruit is distinctly that of a Carya and not of a Juglans, as now defined, but the leaf is more like that of the latter than the former genus. It distinctly falls within the old genus Juglans, but can hardly be reduced to either of its subdivisions which have now been given generic value.

A species of Juglans collected near the same locality as this has been

described by Lesquereux under the name of *J. Schimperi*, but his description and figures indicate a plant different from this one. He describes the leaves of his species as being broadest near the base, long and narrow, having a nervation that differs from that of the leaves before us; the lateral nerves being camptodrome—that is, uniting in festoons along the borders and the tertiary nervation forming rectangular areoles—while in our species a large part of the lateral nerves terminate in the margins and the tertiary nervation is more open and irregular.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Carya antiquorum Newb.

Pl. XXXI, figs. 1–4.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 72; Ills. Cret. and Tert. Pl. (1878), Pl. XXIII, figs. 1–4.

"Leaves pinnate, large, leaflets lanceolate, long-pointed, acute, sessile, finely serrate, middle leaflet broadly lanceolate, widest above the middle, narrowed to the base, which is somewhat unequal; lateral leaflets narrow, lanceolate, unsymmetrical throughout, somewhat falcate; nervation sharply defined, conspicuously parallel, medial nerve straight in the terminal leaflets, more or less curved in the lateral ones; secondary nerves springing from the midrib at a large angle, numerous, subparallel, all arched upward, their extremities prolonged parallel with the margins of the leaf; the upper ones strongly arched, but terminating more directly in the margins; tertiary nerves distinct, mostly simple, straight, and parallel among themselves, connecting adjacent secondary nerves nearly at right angles."

The form, serration, and nervation of these leaves are entirely those of Carya, and while without the fruit it may not be possible to fix their place in the series more definitely than to say that they represent the genus Juglans as formerly constituted, including Carya, we may at least refer them with confidence to a place within the limits of that genus. The leaves of the species of Carya and Juglans are very similar, so much so that some of the Caryas, such as *C. olivæformis*, have leaves that could in the fossil state hardly be distinguished from those of Juglans.

The specimens before us, however, seem to me to be more widely

separated from those of the known species of Juglans than are those of the Pecan, and there seems little doubt that the tree, if now living, would fall within the limits of Carya.

In some specimens the lateral nerves are remarkably straight and numerous, giving to the leaf very much the aspect of those of Æsculus; but, from a comparison of the many leaves of this plant in the collection of Dr. Hayden, I infer that they were not palmately grouped, but pinnate, the form of the bases of the leaves indicating this.

The tertiary nervation is also quite different from that of Æsculus. In the latter genus it usually forms an exceedingly fine network filling the interspaces between the secondary nerves, in which the straight transverse latticelike bars so characteristic of the fossils before us are wanting. At least this is the case with our American "Buckeyes." In *Æ. Hippocastanum* of the Old World something of the kind is visible, but in prevalence and regularity very unlike that in the fossil.

In has been questioned whether these leaves should be referred to Juglans or Carya, and after somewhat extensive comparisons I was led to include them in the latter genus. In looking over the descriptions that have been given of various fossil species of Juglans we find that quite a large number of them should be rather reckoned as pertaining to Carya, taking the fruit as a criterion. For example, in the *J. corrugata* of Ludwig (Palæontogr., Vol. VIII, p. 178, Pl. LXX) the form and the nervation of the leaf is very much like this before us, only the nervation is a little less regular and the marginal serration is coarser. The fruit associated with these leaves is more nearly allied to that of our *J. nigra* than it is to the fruit of the common species of Carya, whereas in the illustrations of *J. levigata*, Brong., given by Ludwig (Palæontogr., Vol. VIII, p. 134, Pl. LIV, figs. 1–6), we have leaves which correspond in a general way with these, as far as form and marginal serration are concerned; nervation exceedingly regular, but more camptodrome, and the fruit distinctly that of Carya. It will be necessary to wait the discovery of the fruits which were connected with these strongly marked leaves, an event which will be likely to occur at no distant date, before deciding to which subdivision of the old genus Juglans it belongs.

Formation and locality: Tertiary (Eocene?). Mouth of Yellowstone River, Montana.

Order MYRICACEÆ.

Myrica (?) trifoliata Newb. n. sp.

Pl. XIV, fig. 2.

Leaves in threes, lance-linear in outline, acute at summit and base; margins remotely and coarsely marked with appressed teeth; nervation delicate.

These are leaves which are manifestly distinct from any others from the Dakota sandstones yet described, and are referred to Myrica with doubt, as nothing but the general resemblance of form and marginal serration can be cited as proof of affinity. In due time, however, more material illustrating the species will be discovered, and, we may hope, also the fruit. At present it stands simply as a positive addition to the list of arborescent plants hitherto found in the Dakota group, but one of which the botanical relations must be determined by future observations.

Formation and locality: Cretaceous (Dakota group). Whetstone Creek, northeastern New Mexico.

Order SALICACEÆ.

Populus acerifolia Newb.

Pl. XXVIII, figs. 5–8.

Ann. N.Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 65; Ills. Cret. and Tert. Pl. (1878), Pl. XIII, figs. 5–8.

"Leaves long-petioled, broad-ovate in outline, often somewhat three-lobed, obtuse, slightly cordate at base, margins coarsely and unequally crenate; nervation radiate, strong; medial nerve straight, giving off one pair of lateral nerves near the center of the leaf, and above these about three smaller ones on each side. From the base of the midrib spring two pairs of lateral nerves on each side. Of these the lower and smaller pair diverge at an angle of 60 degrees to 70 degrees with the midrib, are nearly straight, give off numerous short branches on the lower side, and terminate in the lateral margin below the middle. The second and larger pair of laterals diverge from the midrib at an angle of about 35 degrees to 45 degrees, are straight or slightly curved upward, terminating in the margins

above the middle, or in the lobes, when lobes are developed; from these spring three or four branches on the outside, which, simple or branching, terminate in the scallops of the border. The tertiary nervation, shown very distinctly in some of the specimens, forms a network similar to that of the leaves of living species of Populus, of which the areolæ exhibit considerable diversity of form and size, being polygonal, with a roundish outline, or quadrangular."

Collected by Dr. F. V. Hayden.

The general aspect of these leaves is much like that of some of the living maples, but they are less distinctly trilobate. The crenation of the margin is coarse, irregular, and obtuse or rounded, as is usually the case with the leaves of a group of poplars, the leaves of which in other respects most resemble these. The surface is, in many specimens, somewhat roughened, as though in the living leaf it was canescent; also a common character among poplars, but rare or unknown among maples. The leaves of the maples are generally thin, and the network of the tertiary nerves is remarkably fine and uniform, affording a reliable generic character. This is visible in the leaves of all the recent maples, and is beautifully shown in the impressions of the leaves of *A. pseudoplatanus*, given in Ettingshausen and Pokorny's Physiotypia Plant. Austria, Pl. XVII, fig. 10.

Among fossil species this perhaps resembles most *P. leucophylla* (Foss. Flor. v. Gleichenberg, Denkschrift, k. k. Acad. Wien., Vol. VII (1854), p. 177, Pl. IV, figs. 6–9), but is much more distinctly crenate-toothed on the margin. The teeth of *P. leucophylla* are either obsolete or remote and acute, making a sinuate-dentate margin.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Populus cordata Newb.

Pl. XXIX, fig. 6.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 60; Ills. Cret. and Tert. Pl. (1878), Pl. XIV, fig. 6.

"Leaves orbicular or round heart-shaped, deeply cordate at the base; margins strongly toothed, except the inner border of the lobes of the base;

nervation radiate; medial nerve straight, simple below, branched near the summit; lateral nerves, three pairs diverging at nearly equal angles, from a common point of origin; lower lateral nerves small, simple, arched upward at their summits, terminating in the margins; second pair of lateral nerves springing from the basal point of radiation nearly at right angles with the midrib, arching upward as they approach the lateral margins, and supporting each about three branches on the inner side; third pair of lateral nerves diverging from the midrib at its base at an angle of about 45 degrees, bearing one or two lateral branches, and terminating in the margin above the middle of the leaf."

Of this neat species there are no complete specimens in the collection made by Dr. Hayden, none of them showing the summit of the leaf. Enough is, however, discernible in them to show that they represent a species of Populus different from any other in the collection and from any before described. Of the species at present growing on the North American continent the leaves of *P. heterophylla* approach most nearly to these, but the nervation of the leaves of that tree is never so distinctly radiate.

In the character of its marginal dentations this species resembles *P. mutabilis crenata* Heer, but is clearly distinguished from that by its cordate base and corresponding radiate venation.

Populus Zaddachi Heer (Fl. Tert. Helv., Vol. III, p. 307) has a still closer resemblance to this than either of the species mentioned, and it has been regarded by Lesquereux as identical with it, but in all the figures of that species published the dentation of the margin is less strong and acute and the nervation is less radiate.

In *P. cordata* the basilar pair of lateral nerves reaches the margins below the middle of the leaf, and the second pair of lateral nerves spring from nearly the same point, while in *P. Zaddachi* the basilar pair reach the margin above the middle and the second pair leave the midrib considerably above the origin of the basilars.

The leaf figured by Professor Heer (Fl. Foss. Alaskana; Fl. Foss. Arct., Vol. II, Abth. II, Pl. II, fig. 5), has the character of the fossil before us and would seem to represent the same species. Yet notwithstanding the differences already pointed out, this is referred by Professor Heer to *P. Zaddachi*. The nervation is, however, so different from that of the typical forms of that

species that I am compelled to regard them as distinct till proof is furnished to the contrary.

Formation and locality: Tertiary (Eocene?). Banks of Yellowstone River, Montana.

Populus (?) cordifolia Newb.

Pl. III, fig. 7; V, fig. 5.

Ann. N.Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 18; Ills. Cret. and Tert. Pl. (1878), Pl. V, fig. 5.

"Leaves heart-shaped, slightly decurrent on the petiole; margins entire; nerves fine but distinctly defined; medial nerve straight or slightly curved, running to the margin; lateral nerves, six on each side, given off at an angle of about 50 degrees, nearly parallel among themselves, straight near the base of the leaf, slightly curved toward the summit; lower lateral nerves giving off on the lower side about four simple or once-forked, slightly curved branches, which terminate in the basilar margin; second pair of lateral nerves giving off about three similar branches on the lower side, which run to the lateral margins; third pair supporting about two, and fourth pair one branch on the lower side near the summit; tertiary nerves springing from the secondary nearly at right angles, slightly arched and running across nearly parallel to connect the adjacent secondary nerves."

Collected by Dr. F. V. Hayden.

In its general aspect this species closely resembles the preceding, but several specimens which I have before me agree in being less rounded and more heart-shaped, and the lateral nerves are more numerous and given off at a larger angle.

In these leaves the basilar nerves reach the lateral margins below the middle, and their second branches, as a consequence, have more the aspect of some of the leaves of the Cupuliferæ, such as Corylus. The latticelike arrangement of the tertiary veins in this, as in the other species of the group, is very characteristic of the Cupuliferæ, though not strictly limited to them. If we could imagine a Corylus with rounded or broadly cordate leaves, of which the margins were entire, we should have a very near approach to these plants.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Populus cuneata Newb.

Pl. XXVIII, figs. 2–4; XXIX, fig. 7.

Ann. N.Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 64; Ills. Cret. and Tert. Pl. (1878), Pl. XIII, figs. 2–4, under *P. nervosa* var.; and Pl. XIV, fig. 7, under *P. Nebrascencis.*

"Leaves small, obovate, somewhat wedge-shaped at the base, obtusely pointed at the summit, coarsely, obtusely, and irregularly dentate on the margins, three-veined, basilar nerves given off at an acute angle, terminating above the middle of the margin; secondary nerves few-forked, and often inosculating."

This species is represented by numerous specimens in the collection made by Dr. Hayden. It will be seen to be distinctly separable from any of the species published with it, and the same may be said in regard to those published elsewhere. In general form it bears some resemblance to *P. attenuata*, Al. Braun (Heer, Fl. Tert. Helv., Vol. II, p. 15, Pl. LVII, figs. 8–12, and Pl. LVIII, figs. 1–4); also to some forms of *P. mutabilis*? Heer; but the nervation is less crowded than in those species, and both are acuminate-pointed. An elongated form is shown on Pl. XXIX, fig. 7.

Formation and locality: Tertiary (Eocene ?). Banks of Yellowstone River, Montana.

Populus cyclophylla Heer.

Pl. III, figs. 3, 4; IV, fig. 1.

Proc. Phila. Acad. Nat. Sci., 1858, p. 266. Lesq., Ills. Cret. and Tert. Pl. (1878), Pl. III, figs. 3, 4; Pl. IV, fig. 1, under *P. litigiosa* Heer.

Populites cyclophylla (*Populus*) Heer. Lesq., Am. Journ. Sci., Vol. XLVI (July, 1868), p. 93.

Populites cyclophylla (Heer)? Lesq., Cret. Fl. (1874), p. 59, Pl. IV, fig. 5; Pl. XXIV, fig. 4.

The specimens upon which Heer founded his species are given on Pl. III, and are before me as I write. The smaller specimen represented by fig. 3 is characteristic and normal, except that it is not more than half the average size of the leaves of this species. Fig. 4 is but a fragment, and it is very doubtful whether it should be considered as belonging to *P. cyclophylla.* The leaf figured on Pl. IV is about of the average size, and though incomplete, may be accepted as a fair representative of the species. Such leaves are not uncommon in the Dakota group at Fort Harker, and a

precisely similar one is figured by Lesquereux on Pl. IV of his Cretaceous Flora. It is more than doubtful whether any of these leaves belong to a true Populus; the nervation is more distinctly and regularly pinnate than in any living species of the genus, and the probability is that we have here the relics of a genus of trees now extinct, but closely related to the poplars.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska, and Fort Harker, Kansas.

Populus (?) Debeyana Heer.

Pl. IV, fig. 3; V, fig. 7.

Nouv. Mem. Soc. Helv. Sci. Nat., Vol. XXII (1866), p. 14; Pl. I, fig. 1.
Juglans Debeyana (*Populus*?) Heer, Lesq. Am. Journ. Sci., Vol. XLVI (July, 1868), p. 101.
Juglans (?) *Debeyana* Heer, Lesq. Cret. Fl. (1874), p. 110, Pl. XXIII, figs. 1–5; Ills. Cret. and Tert. Pl. (1878), Pl. IV, fig. 3; V, fig. 7.

A number of leaves in the collection made by Dr. Hayden are clearly identical with that referred with doubt by Professor Heer to Populus from the generalities of its nervation, and impressions of what would seem to have been glands at the base on either side of the point of insertion of the petiole. In our specimens, however, there are no glandular impressions, and the departure from the normal type of nervation in Populus noticed by Professor Heer is still more conspicuous.

The strong pair of basilar nerves so characteristic of the poplars is entirely wanting, the inferior lateral nerves being small, and the stronger ones, which succeed them above, are not opposite. In view of the marked departure which these leaves exhibit from the nervation and form of the typical poplars, Professor Heer suggests that they may represent an extinct genus of the order Salicineæ, but it seems to me their affinities are closer with the Magnoliaceæ, and that it is even probable that they represent a species of the genus Magnolia.

Lesquereux has suggested that this leaf should be referred to Juglans, comparing it with *J. latifolia* Heer, from the Tertiary of Switzerland; but a considerable number of specimens before me fail to convince me of the justice of this reference, and yet they hardly suggest any other botanical relations. The leaves were evidently very thick and leathery, and the nervation is crowded and strong. It will be necessary that some

other parts of the plant shall be obtained before this question can be satisfactorily settled.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Populus elliptica Newb.

Pl. III, figs. 1, 2.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 16.
Ficus ? rhomboideus Lesq. Am. Journ. Sci., Vol. XLVI (July, 1868), p. 96; Ills. Cret. and Tert. Pl. (1878), Pl. III, figs. 1, 2.
Phyllites rhomboideus, Lesq. Cret. Fl. (1874), p. 112, Pl. VI, fig. 8.

"Leaves long-petioled, suborbicular or transversely elliptical, slightly cuneate at the base, and apiculate at summit; lower half of leaf entire; superior half, or more, very regularly and rather finely obtusely serrate, or crenate, the points of the teeth inclining upward; primary nerves usually five, sometimes three, radiating from the base at equal angles; from these the secondary nerves spring at acute angles."

This is an exceedingly neat and well-defined species, very fully represented in Dr. Hayden's collections. It is symmetrical in form, broader than high, forming a transverse ellipse, from the opposite sides of which rise the corresponding and equal projections of the apiculate summit and slightly decurrent base. The crenation of the upper portion of the leaf is very regular and neat, the teeth of small size, and turned upward. The general aspect of the leaf is not very different from that of some specimens of the living *P. tremuloides*, but the entire margins at the lower half of the leaf, the more elliptical outline, shorter point, and larger and more regular teeth, mark its specific differences with sufficient distinctness, while the correspondence which the leaves of the two species present in the general characters of form, nervation, and crenation, affords satisfactory evidence of generic identity.

In the Tertiary plants collected by Dr. Hayden on the upper Missouri a species of Populus occurs (*P. rotundifolia*), which exhibits a striking resemblance in general form to that now under consideration. In that species, however, the crenation of the superior margin is uniformly coarser and less acute, and the nervation is more delicate.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Populus flabellum Newb

Pl. XX, fig. 4.

Boston Journ. Nat. Hist., Vol. VII. (1863), p. 524.

"Leaves flabellate, orbicular or reniform, obtuse, wedge-shaped at base, slightly decurrent onto the petiole. Margins entire or waved; principal nerves three, two lateral ones reaching nearly to the summit; secondary nerves fine, flexuous, forked."

There is no living species of Populus of which the normal form of the leaves approaches very closely to that of those under consideration, though one, three-nerved like these, may be occasionally found among the round-leaved poplars. Among the Tertiary plants collected by Dr. Hayden on the Yellowstone is a species, yet unpublished, very much like this, both in the form and nervation of the leaves, and among the Cretaceous plants collected by him in Nebraska is another nearly equally like it; but in both these the upper margins of the leaves are more or less crenulated.

Formation and locality: Cretaceous (Puget Sound group). Chuckanutz, near Bellingham Bay, Washington.

Populus genetrix Newb.

Pl. XXVII, fig. 1.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 64; Ills. Cret. and Tert. Pl. (1878), Pl. XII, fig. 1.

"Leaves large, cordate in form, acuminate; margins serrate, with rather small appressed teeth; three-nerved; nervation sparse but strong; midrib straight, with few small branches; basilar nerves very strong, given off at an acute angle, much branched at the summit, reaching nearly to the margin far above the middle; from each of the basilar-lateral nerves spring five to six exterior branches, the lower ones very strong and branched, the upper slender and simple."

In general aspect this leaf is very similar to that of the living *P. balsamifera*, and apparently differs from it only in its nervation. It is more decidedly three-nerved than those of any of the living group which it may be supposed to represent—*P. balsamifera*, *P. candicans*, *P. monilifera*, etc.; yet one may occasionally find a leaf of either of these species which in this respect approaches the fossil before us. The dentation of the margin is

essentially that of *P. balsamifera*, and it can hardly be doubted that we have here the progenitor of one or more of the group of poplars with which I have compared it, and which now grow in the region where these fossil plants were collected.

The different species of Populus among the Tertiary plants collected by Dr. Hayden are far more generally three-nerved than are the living species which now inhabit this country. In this respect they resemble more the foreign *P. alba;* and it may be said that the majority of species described in this memoir are more closely allied to the section Coriaceæ than to the Balsamitæ.

Professor Schimper, in his *Paléontologie Végétale*, Volume II, page 690, refers this species to *Populus balsamoides* Goepp., basing this conclusion upon manuscript information received from Professor Heer. It is impossible, however, to harmonize the discrepancies which exist between the specimens before us and the figures and descriptions of Professor Heer. (Fl. Tert. Helv., Vol. II, p. 18, Pl. LIX; LX, figs. 1–3; LXIII, figs. 5, 6; Vol. III, p. 173.) In all the figures and descriptions given of *P. balsamoides* the medial nerve is far stronger than the lateral nerves. These form many pairs, of which the lower reach the margins below the middle of the leaf. On comparing the figure now given it will be seen that the differences are very marked, for the leaf of *P. genetrix* is practically three-nerved; at least the midribs and the two chief lateral nerves are nearly of equal strength. The lower pair of lateral nerves may be considered as mere branches of the second pair. From these differences I am compelled to regard *P. genetrix* and *P. balsamoides* as distinct species.

Formation and locality: Tertiary (Eocene ?). Banks of Yellowstone River, Montana.

Populus litigiosa Héer.

Pl. III, fig. 6.

Nouv. Mem. Soc. Helv. Sci. Nat., Vol. XXII (1866), p. 13, Pl. I, fig. 2; Ills. Cret. and Tert. Pl. (1878), Pl. III, fig. 6.

The specimen of which the figure is cited above is that of which a tracing was sent by Mr. Meek to Professor Heer, and on which he based his description. This specimen is too imperfect to furnish a full diagnosis

of the species or to afford comparison with the other fossil plants with which it is associated.

It is evident, however, that the general form of the leaf and the character of the nervation are similar to those of *P. cyclophylla* Heer, but it would seem that the margin is somewhat waved, and the nervation is rather more open than in the larger specimens of the species with which I have compared it. The basal pair of nerves also form a slightly greater angle with the midrib, and branches given off from them below are longer, supplying a broader expanse of the leaf. Like several of the other less common leaves of the Dakota group, these must remain as somewhat doubtful material until further collections shall add to our knowledge of them.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Populus microphylla Newb.

Pl. III, fig. 5.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 17; Ills. Cret. and Tert. Pl. (1878), Pl. III, fig. 5.

"Leaves very small, scarcely an inch in length, roundish in outline, somewhat wedge-shaped at base, where they are entire; the upper part of the leaf rounded and deeply toothed, teeth conical, acute or slightly rounded at the summits; nerves radiating from the base, branching above, the branches terminating in the dentations of the margin."

This very neat species, from the collection made by Dr Hayden, might be supposed to be only a form of *P. elliptica*, with which it is associated, but a number of specimens of each show no shading into each other, and it is scarcely possible that so wide a variation of marginal dentation should exist in the same species. Although the leaves of *P. elliptica* are two or three times as large as those of the species under consideration, the teeth of the margins are less than half the size and are of a different type, being inclined upward, the sides of each tooth of unequal length, while the dentations of *P. microphylla* are conical in outline, with nearly equal sides.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Populus Nebrascencis Newb.

Pl. XXVII, figs. 4, 5.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 62; Ills. Cret. and Tert. Pl. (1878), Pl. XII, figs. 4, 5.

"Leaves long-petioled, 2 to 3 inches long, ovate, pointed, regularly rounded at the base, coarsely and irregularly toothed except near the base where the margins are entire; nervation strong, radiating from the base of the leaf; medial nerve straight, simple (or supporting very small nerves), except near the summit, where two or three larger branches rise from it; lateral nerves, two pairs on each side, springing from a common point of origin; lower pair arched upward, nearly parallel with the margin of the leaf, to which they send off one or more simple branches; second pair of laterals diverging from these at an angle of 30 degrees, arching upward, and running parallel with the midrib, terminating in the margin near the summit, each giving off about three exterior branches, which curve upward and terminate in the dentations of the border."

This species, by its general form and nervation, approaches closely to *P. smilacifolia*, but the base is rounded (sometimes slightly wedge-shaped), never distinctly cordate; the superior lateral nerves are not quite so much drawn together toward the summit, and the margins are differently and much more coarsely dentate.

A large number of specimens of this species present constant and distinctive characters. They exhibit considerable variation in size, being from 1 to 3 inches in length, but in form, nervation, and marginal dentation they are alike.

These specimens, from the collections made by Dr. F. V. Hayden, are derived from different localities, and without doubt represent a distinct species which was spread over the Tertiary continent.

By the character of the impressions left on the stone, as well as by the coarse and unequal dentation of the margins, we may infer an affinity between this and the downy-leafed poplars of the present epoch, such as *P. alba* of Europe, etc., while in the smooth surface and finely denticulate or entire margin of *P. smilacifolia* we have evidence of resemblance to *P. tremuloides*.

There is no fossil species for which this can well be mistaken. Some of the forms of *P. crenata* Unger (Foss. Fl. Sotzka, p. 166 [36], Pl. XXXVI [XV], figs. 2–5) resemble these leaves, but they are not so distinctly radiate nerved. Unger represents the teeth of the margin as more acute, and more like those of *P. tremula*, with which he compares his fossil species.

Some varieties of *Populus Zaddachi* Heer (Fl. Tert. Helv., Vol. III, p. 307; Fl. Foss. Arct., Vol. I, p. 98, Pl. VI, figs. 1–4; XV, fig. 1b) are somewhat like this species, and it has been suggested by Mr. Lesquereux that they are identical; but in all the figures of that species published the margins are serrate-dentate, whereas in the leaves before us they are much more closely crenate-dentate; also most of the leaves are cordate at the base, and this is a feature given by Heer in his description, but among quite a large number of the leaves of *P. Nebrascencis* which have served as a basis for the specific description, the form is ovate, the base rounded, sometimes a little produced, but never cordate or even emarginate.

Formation and locality: Tertiary (Eocene?). Banks of the Yellowstone River, Montana.

Populus nervosa Newb.

Pl. XXVII, figs. 2, 3.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 61; Ills. Cret. and Tert. Pl. (1878), Pl. XII, figs. 2, 3.

"Leaves rounded in outline, margins nearly entire, or slightly serrate at the base, sharply but not deeply toothed on the sides, on the summit strongly doubly serrate, with a tendency to become three-lobed; nervation strongly marked and crowded; basal nerves springing from the midrib above the margin, given off at an angle of 30 degrees or more, reaching the margin above the middle, where they terminate in the most prominent teeth or lobes; from these basilar nerves are given off five or six strong lateral nerves, which arch upward and, more or less forked, terminate in the marginal teeth; above the basilar nerves three or four pairs of strong lateral nerves are given off from the midrib, which run parallel with the basilar pair, and terminate, like them, in the compound teeth of the upper margin. The lateral nerves are connected by numerous strong secondary nerves,

which are generally simple and slightly arched, sometimes broken, and anastomosing with each other. This latter character gives a lattice-like appearance to the leaf, to a degree unusual in the genus."

Collected by Dr. F. V. Hayden.

The strong nervation of this species is one of its most marked characters, and has suggested the name given to it. By this and the double dentation of the superior margin, as well as by their acerine form, these leaves are easily distinguishable from any of those with which they are associated and any hitherto described.

Formation and locality: Tertiary (Eocene?). Banks of Yellowstone River, Montana.

Populus nervosa elongata Newb.

Pl. XXVIII, fig. 1.

Populus nervosa var. B. *elongata* Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 62; Ills. Cret. and Tert. Pl. (1878), Pl. XIII, fig. 1.

"Leaves ovoid or oblong in outline, wedge-shaped at base, abruptly pointed at summit, basal margins entire, sides rather finely toothed, superior margin, coarsely, somewhat doubly dentate; nervation strongly marked, less crowded than in var. A.; basal nerves springing from the midrib above the basal margin nearly straight, reaching the sides above the middle and terminating in the first large dentations of the upper margin; exterior lateral nerves of the basal pair, three or four in number, remote, nearly simple, curved upward, and terminating in the lateral teeth; secondary nerves above basal pair, three on each side of the midrib, parallel with the basal pair, and connected with them, each other, and the midrib, by numerous strong, generally simple, lattice nerves."

Collected by Dr. F. V. Hayden.

The nervation of these leaves is essentially the same as that of those last described, and which, notwithstanding the difference of form that they represent, I am inclined to consider as belonging to the same species. This diversity of form is not greater than may be seen in the leaves of any poplar tree, and the differences of dentation are not greater than those observed in different leaves of many living and fossil species. The origin of the large basilar nerves *above* the base of the leaves, the strong and

latticed nervation, and the dentation of the same general character, with the fact that all the specimens are from the same locality, all combine to lead me to consider the two forms as specifically identical

Formation and locality: Tertiary (Eocene?). Yellowstone River, Montana.

Populus polymorpha, Newb.

Pl. XLVI, figs. 3, 4; XLVII, fig. 4; XLIX, figs. 4, 7, 8, 9 [misprinted 1]; LVIII, fig. 4.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 506.

"Leaves petioled, ovate, rounded or slightly wedge-shaped at the base, acute or blunt-pointed at the summit; margins coarsely and irregularly crenate, dentate, or crenate-dentate; nervation strongly marked, pinnate; in the more elongated forms, about eight branches on each side of the midrib given off at an acute angle; in the broader forms the lower nerves issue at nearly a right angle; the upper ones at an angle larger than in the preceding form."

The leaves of this tree are the most numerous of all represented in the collection from Oregon made by Rev. Thomas Condon, several hundred in greater or less completeness being included in the specimens which have been passed in review. They show a marked diversity of form, some being long ovoid or elliptical, rather pointed at base and summit; others ovoid or roundish with a rounded base; some are light and delicate, others have strong nerves, and evidently were thick and leathery in texture. More generally a base similar to that on Pl. XLIX, fig. 9, accompanies a summit coarsely dentate or crenate.

It is with some hesitation that this leaf has been referred to Populus, but it presents greater affinities in nervation and marginal markings with this group than any with which they have been compared. The general aspect of the leaf represented on Pl. XLVI, fig. 4, is quite that of some of the poplars, particularly of the group represented by the abele (*P. alba*, L.), while the specimens figured on Pl. XLIX, figs. 4 and 7, and Pl. XLVII, fig. 4, are so different from the prevailing style of poplar leaves that the propriety of referring them to this genus seems questionable. There are, however, connecting links between all these different forms, and the general

resemblance of the group to the leaves of the poplars is strong enough to warrant their provisional association.

Among the fossil leaves which have been described as species of Populus some of the many forms of *P. mutabilis* Heer show a considerable resemblance to these before us, and one phase of *Populus leucophylla* Ung. (Fl. Gleichenberg, p. 177 [21], Pl IV, figs. 6–9), especially that represented in fig. 9 of the plate cited, could hardly be distinguished from some of the Bridge Creek leaves

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Populus rhomboidea Lesq.

Pl. XX, figs. 1, 2.

Am. Journ. Sci , Vol. XXVII (1859), p. 360.

In the collection of the Northwest Boundary Commission are numerous specimens which I have referred with some doubt to species of Populus described by Lesquereux. My specimens are, however, too imperfect to permit me to decide with certainty the question of their identity. Associated as they are with Inoceramus, there can be no reasonable doubt of their Cretaceous age.

Among the fossil leaves brought from Orcas Island, there are some which bear considerable resemblance to these, but they are too imperfect to render the comparison satisfactory.

Formation and locality: Cretaceous (Puget Sound group). Nanaimo, Vancouvers Island.

Populus rotundifolia Newb.

Pl. XXIX, figs. 1–4.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 506; Ills. Cret. and Tert. Pl. (1878), Pl. XIV, figs. 1–4, under *P. cuneata.*

"Leaves of small size, rarely more than an inch in diameter, approximately circular in outline, either quite round or transversely or longitudinally elliptical; slightly wedge-shaped at the base, and decurrent on the long petiole; basal margin entire; upper half of leaf coarsely crenate, dentate, and usually short pointed at the summit; nervation flabellate, consisting of a median and two principal lateral nerves, which give off numerous branches"

When the leaf is more than usually elongated, as in fig. 3, the basilar nerves spring from the midrib a little below the junction of the main lateral branches. The normal form is well represented in fig. 1, but it is not unusual to see those which are slightly flabelliform, like fig. 4. The tissue of the leaf would seem to have been thick and leathery, since the surfaces are unusually smooth, and the nerves sunk in the parenchyma are often scarcely perceptible.

The leaves described above present some anomalies in form and structure as compared with most of our poplars, since they are frequently flabelliform, and were apparently of much thicker and denser tissue than those of any living species. They present, however, a marked resemblance to those described and figured in this report under the names of *P. elliptica* and *P. flabellum*, one from the Dakota group of Kansas, the other from the Upper Cretaceous of Orcas Island on the northwest coast, and *P. cuneata* from the Tongue River Tertiary; and all the group, in form, nervation, and serration, have sufficient likeness to some of the living poplars, particularly to *P. tremuloides* of America and *P. pruinosa* of Songaria, to warrant their being included in the same genus.

There are some tropical trees of which the leaves present considerable resemblance to our fossils, especially one of the Proteaceæ (*Adenanthos cuneatus* of Australia), the leaves of which are small, cuneate at base, rounded at summit, where they are coarsely crenate, having almost precisely the form of one of the specimens of the fossil in question. This is, however, apparently an abnormal form, and the similarity which I have noticed is perhaps accidental and certainly of little value. The nervation of these fossil leaves is considerably different from that of Adenanthos, and a mere resemblance in form, however close, would hardly warrant us in supposing that the fossil plant could have any very near affinity with one so far removed geographically and botanically from the flora with which it is associated.

Probably all the specimens represented by figs. 1, 2, 3, and 4 belong to one species, though that from which fig. 3 was taken was obtained in a different locality from any of the others and has a somewhat different aspect. Taken by itself this might readily be supposed to belong to a rosaceous plant, perhaps a Rubus, Pyrus, or Cratægus; but it would be difficult to find its exact counterpart in any living species of these genera. It is perhaps

safer to consider it only an unusual form of fig. 1 and refer it provisionally to the same species. Its geological value will be secured by the truthful figure given of it.

Formation and locality: Tertiary (Eocene?). Yellowstone River, Montana; Fort Union, Dakota; Carbon Station, Wyoming.

Populus smilacifolia Newb.

Pl. XXIX, fig. 5.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 66; Ills. Cret. and Tert. Pl. (1878), Pl. XIV, fig. 5.

"Leaves ovate, pointed, slightly cordate at the base; margins finely and obtusely crenulated; nervation radiate, delicate and sparse; medial nerve straight, giving off only fine and scarcely perceptible lateral nerves below, and two or three longer branches near the summit; two pairs of lateral nerves radiate with the medial nerve from the same point at the base of the leaf; of these the lower two are small, nearly simple, and arched evenly upward; the other two, nearly as strong as the midrib, spring from the base at an angle of about 25 degrees, and after diverging to the middle of the leaf, curve upward toward the summit, near which they terminate in the margins. These lateral nerves support four or five simple or once-forked branches, each given off exteriorly, which curve upward, and terminate in the lateral margins. The tertiary nerves are given off nearly at right angles from the secondaries and form a delicate polygonal or quadrangular network over the surface of the leaf."

Collected by Dr. F. V. Hayden.

The lower pair of lateral nerves should properly be considered as branches of the larger ones, so that the leaf is more distinctly three-veined than that of any living species of Populus. This character, with the smooth surface and nearly entire margins, gives these leaves the general aspect of those of Smilax and suggested the name given them. Their nervation, however, is sufficiently distinct from that of Smilax, and is clearly that of Populus, though in a somewhat exaggerated form. In Smilax three or five nerves radiate from the base of the leaf and terminate together at the summit, which those of the leaves of Populus never do. In Smilax, too, the principal nerves give off no large branches, but all the

interspaces are filled with a labyrinth of anastomosing veins, forming a very different network from that of Populus.

The marginal serration of the present species would seem to have been much like that of the leaves of the living *P. tremuloides*, but still finer, while the size of the leaf was considerably larger.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

POPULITES ELEGANS Lesq.?

Pl. VIII, fig. 3.

Am. Journ. Sci., Vol. XLVI (July, 1868), p. 94.

NOTE.—So identified by Dr. Newberry, as indicated by memorandum on the margin of the plate.—A. H.

Formation and locality: Cretaceous (Dakota group). Fort Harker, Kansas.

SALIX ANGUSTA Al. Br.?

Pl. LXV, fig. 2.

In Bruckm. "Fl. Oening. Foss." Würtemb. Naturwiss. Jahresh. (1850), p. 229. *S. angustifolia* Al. Br., in Buckland, Geol. and Mineral., p. 512 (1837).[1]

A very narrow-leaved willow; is exceedingly common in the Green River beds, some slabs of the rock being quite covered with the leaves. These are narrow, lanceolate, tapering gradually to a long and strong petiole and to a long, narrow, and acute point above. The margins are entire and sharply defined, the midrib strong, the lateral nerves numerous and fine.

In general form these leaves agree very well with the excellent figures of *Salix angusta*, given by Heer in his Fl. Tert. Helv., Vol. II, p. 30, Pl. LXIX, figs. 1–11, but the base is in our specimens narrower, so much so that the blade seems to be decurrent on the petiole. The leaves from Green River apparently represent the same species as that figured by Lesquereux, (Tert. Fl., p. 168, Pl. XXII, figs. 4, 5) but perhaps not that shown in fig. 5, as in all the many specimens now before me the base is narrower and more

[1] The oldest published name for this species is *S. angustifolia* Al. Br., 1837, but this name was preoccupied by the living species. This fact was apparently recognized by Braun, as he subsequently changed it to *S. angusta*, which is here adopted.—A. H.

wedge-shaped than the latter. Unfortunately the specimen represented in fig. 4 has the base and summit broken away, and the identification is therefore not absolutely certain, but as it was obtained in the same region where Dr. White collected the narrow-leaved willows before us there is every probability that they are the same.

Whether the narrow-leaved willow of the Green River beds is identical with that found in the so-called Miocene or Oeningen is, however, an open question. That both are willows there can be no reasonable doubt, but the leaves of so many species of willow are narrow lanceolate with tapering bases and summits that it is quite impossible to be sure of an identification based on a mere general resemblance. All we can say, therefore, is that during the deposition of the Green River Tertiary beds willow trees grew on the banks of the rivers and lakes of that region, having long, narrow leaves with simple margins and undistinguishable by any well-marked character from those obtained from the Tertiary of Oeningen.[1]

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Salix cuneata Newb.

Pl. II, figs. 1, 2.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 21; Ills. Cret. and Tert. Pl. (1878), Pl. I, figs. 1, 2 [fig. 1 under *Salix Meekii*].

"Leaves of medium size, sessile or short-petioled, entire, elongate, narrow, acute at both ends, broadest toward the apex, gradually narrowed below to the base; medial nerve distinct; secondary nerves delicate, springing from the midrib at an angle of about 20 degrees near the middle of the leaf, 15 to 20 degrees below, straight and parallel near the bases, gently arched above and inosculating near the margins."

Collected by Dr. F V. Hayden.

This species presents some marked characters by which it may be distinguished from those before described. It is true that the variations of form among the leaves of our recent species of willow are almost infinite, and even in the same species and from the same tree leaves may be obtained

[1] A comparison of our figure with those of Heer and Lesquereux leads me not only to doubt their identity, but to think that ours is more likely to be a Eucalyptus. The marginal nervation is certainly more characteristic of the latter genus than of Salix.—A. H.

of such different aspect that, taken separately, they might readily be mistaken for those of different species. Since the difficulty in the determination of recent willows is so great that it has become proverbial, specific distinctions derived from the leaves only, especially in those obtained from the same locality, may justly be looked upon with suspicion. Here, as elsewhere, however, it is probable that recent botany will derive some aid from the careful study of fossil plants, and the nervation will probably be found to afford constant characters where the outlines of the leaves can hardly be relied on.

It may be seen by reference to the foregoing descriptions of Salices that a number of characters combine to distinguish what, for geological convenience, I have chosen to regard as distinct species.

Salix Meekii is lanceolate, tapering nearly equally to both ends, which are alike acute; this leaf is petioled and the nervation regular and delicate.

S. flexuosa is sessile, linear, and rather abruptly narrowed to point and base; nervation obscure, apparently very delicate and uniform.

S. cuneata is comparatively thick and leathery, the form symmetrical, lanceolate, pointed, but scarcely acute at both ends; the midrib strong, prolonged into a short, robust petiole; secondary nerves unequal, given off at a large angle, thick at base, slender, tortuous, and irregularly confluent near the margins.

In *S. membranacea* the leaves are large and thin, broadest near the base, which is rounded, summit long-pointed and acute; nervation distinct and regular, but delicate.

Formation and locality: Cretaceous (Dakota group). Mouth of Big Sioux River, Nebraska.

Salix flexuosa Newb.

Pl. II, fig. 4; XIII, figs 3, 4; XIV, fig. 1.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 21; Ills. Cret. and Tert. Pl. (1878), Pl. I, fig. 4.

"Leaves narrow, linear, pointed at each end, sessile or very short-petioled; medial nerve strong, generally somewhat flexuous; secondary nerves pinnate, leaving the principal nerve at an angle of about 40 degrees, somewhat branched and flexuous, but arching so as to inosculate near the margins."

This is perhaps only a variety of *S. Meekii*, which it resembles in its nervation, as far as can be observed in specimens fossilized in sandstone, but, although much narrower in its general form, it is less acuminate at either extremity, and is apparently sessile. As in some of our living narrow-leaved willows, these leaves are generally somewhat flexuous, and as they are seen lying in their natural curves on the surfaces of the rock they have as familiar and perfectly willowlike a look as leaves of *Salix angustifolia* would if artificially fossilized in the manner followed by Goeppert.

Since the above description was written I have collected this species from a number of widely separated localities and found it to hold its character with great constancy.

Formation and locality: Cretaceous (Dakota group). Big Sioux River, Blackbird Hill, Cedar Spring, etc., Nebraska, and Whetstone Creek, New Mexico.

Salix foliosa Newb. n. sp.

Pl. XIII, figs. 5, 6.

Leaves long-petioled, broadly linear; 8 to 9 inches long by 1 inch wide; suddenly narrowed to the base; acute at the summit; margins entire, sometimes undulate; nervation delicate.

Leaves of this species occur in great abundance on the banks of Whetstone Creek in northeastern New Mexico, and characteristic figures are given of specimens collected by myself in that locality. The leaves are larger than those of any other known Cretaceous Salix, unless it be *S. membranacea;* but it differs from that in its leaves being wedge-shaped instead of rounded at the base.

From the locality referred to, where the fossils are contained in a fine-grained, light-colored sandstone, in which the most delicate tissues would be preserved, we may expect the fruit of these and other fossil plants to be discovered, with a decided illumination of the botanical affinities of the plants of the Dakota group.

Formation and locality: Cretaceous (Dakota group). Whetstone Creek, New Mexico.

Salix Meekii Newb.

Pl. II, fig. 3.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 19; Ills. Cret. and Tert. Pl. (1878), Pl. I, fig. 3 [under *S. cuneata*].

"Leaves petioled, thin and delicate, lanceolate, acute at both ends, nervation delicate, midrib slender, secondary nerves fine, springing from the medial nerve at an angle of 35 degrees, gently arched and anastomosing near the margins; network of tertiary veins somewhat lax, but composed of nervules of such tenuity as to be rarely visible."

This is the plant of which an outline sketch was sent Professor Heer by Mr. Meek. In that sketch the general form was alone given, the details of nervation, as well as the texture of the leaf, not being deducible from it. Professor Heer considered it a Laurus, and as probably identical with *Laurus primigenia* Ung., a common species in the Tertiary of Europe. Aside from the *a priori* improbability of this plant, found in the Middle Cretaceous rocks, being identical with one which in the Old World dates back no further than the Miocene, there are characters in the fossil itself which seem to separate it from even the genus Laurus. The nervation has a different aspect from that of any of the Lauraceæ with which I am acquainted, being both more lax and delicate, the secondary nerves less accurately arched, and their summits more wavy; the patterns formed by their anastomosis less regular and determinate. In these respects, as well as in its comparatively thin and delicate texture, it resembles much more the willows than the laurels.

It seems hardly worth while to compare the plant before us with any of the living willows, for everything indicates that all the species of the Cretaceous, both vegetable and animal, long since perished Among the great number of fossil species found in the Tertiary strata there are several which have a general resemblance to it and from which it might be unwise to regard it as distinct if they were from the same formation. *Salix elongata* Web. (Palæontogr. (1852), Pl. XIX, fig. 10) has nearly the same form, but the secondary nerves are given off at a larger angle and are much more arched.

From its associate species in the Cretaceous strata it seems not difficult to distinguish it. *Salicites Hartigi* Dunker (Palæontogr. (1856), p. 181,

Pl. XXXIV, fig. 2) is apparently much more strongly nerved. The general form was perhaps similar, although Dunker's specimen wants both point and base.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

SALIX MEMBRANACEA Newb.

Pl. II, figs. 5–8,[1] 8a.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 19; Ills. Cret. and Tert. Pl. (1878), Pl. I, figs. 5–8a [fig. 8a not named on plate].

"Leaves petioled, large, smooth, and thin, lanceolate, long-pointed, rounded or abruptly narrowed at the base, near which they are broadest; margins entire; medial nerve slender, often curved, secondary nerves remote, very regularly and uniformly arched from their bases, terminating in or produced along the margins till they anastomose; tertiary nerves given off nearly at right angles, forming a very uniform network of which the areoles are polygonal and often quadrate."

This is a strongly marked species, collected by Prof. George H. Cook, of which I have specimens fossilized in fine clay and exhibiting with great distinctness all the details of nervation. It was evidently thin and membranous in texture, though attaining a large size. Like most of the willows, it is frequently unsymmetrical, one side being most developed and the midrib curved.

The leaf is broadest near the base, and is thence narrowed into a long and acute point.

Formation and locality: Cretaceous (Raritan). Amboy Clays, Raritan River, New Jersey.

Order BETULACEÆ.

CARPINUS GRANDIS Ung.

Pl. LIV, fig. 3, in part; LV, fig. 6.

Synop. Foss. Pl. (1845), p. 220.

Leaves which seemed to represent this very widespread species of Carpinus were collected by Professor Dana at Birch Bay, near the mouth

[1] This specimen may also be found figured in Flora of the Amboy Clays, Pl. XXIX, fig. 12. (Mon. U. S. Geol. Surv., Vol. XXVI.)—A. H.

of Frazer River, and appear in Pl. XXI, fig. 10, of the Atlas which accompanies the Geology of the Wilkes Exploring Expedition. Upon the same slab are seen the branches of *Glyptostrobus Ungeri* (?), the branchlets and cone of *Taxodium distichum miocenum*, leaves of *Rhamnus Gaudini* (?), and *Smilax cyclophylla* Newb. Some of these are reproduced on Pl. LIV, fig. 3 (Carpinus and Smilax); Pl. LV, figs. 3 to 6 (Glyptostrobus, Taxodium, Carpinus). Very few fossil plants were brought from this locality, but they seem to represent a horizon somewhat different from that which has supplied any other specimens in the collection. Leaves of various kinds appear to be exceedingly abundant and beautifully preserved there, and it is to be hoped that the locality may be visited by some other collectors, who shall bring us a fuller representation of its riches.

Formation and locality: Tertiary (Eocene ?). Birch Bay, Washington.

Corylus Americana fossilis Newb.

Pl. XXIX, figs. 8–10.

Corylus Americana Walt. Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 59; Ills. Cret. and Tert. Pl. (1878), Pl. XIV, figs. 8–10.

Among the variety of specimens of the leaves of *C. Americana* with which I have compared these fossils, there are some which, if fossilized, would form impressions absolutely undistinguishable from them, and I have therefore found it impossible to fix upon any characters by which they can be separated. As compared with the fossils which I have referred to *C. rostrata*, these leaves are a little more rounded in outline, the nervation somewhat more open and delicate, the marginal teeth more nearly equal in size, and more obtuse.

Of all the species of Corylus, living or fossil, which have been described, there is none of which the leaves so much resemble the ones under consideration as do those of *C. Americana.*

Collected by Dr. F. V. Hayden.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Corylus MacQuarrii (Forbes) Heer.

Pl. XXXII, fig. 5; XLVIII, fig. 4.

Alnites ? MacQuarrii Forbes. Quart. Journ. Geol. Soc. London, Vol. VII (1851), p. 103, Pl. IV, fig. 3.
Corylus MacQuarrii Heer. Urwelt. d. Schw. (1865), p. 321.
Corylus grandifolia Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 59; Ills. Cret. and Tert. Pl. (1878), Pl. XV, fig. 5.

"Leaves large (5 to 6 inches long), short-petioled, unequally cordate at the base, pointed above, coarsely and unequally dentate; nervation strong; midrib straight or curved, not sinuous; lateral nerves, six to seven pairs; lower pair diverging at a larger angle than the upper ones, and supporting a number of short, generally simple, branches, on the lower side, which terminate in the basal margin; second pair diverging at an angle of 45 degrees, reaching the margin about the middle, supporting about four branches on the outside; upper pair simple or branched once, rarely twice."

Collected by Dr. F. V. Hayden.

This was evidently a large, thick, roughish leaf, having more the aspect and texture of the leaves of the mulberry than of the hazel. The nervation is, however, much nearer that of the latter genus. Indeed, in all essential characters it is the same as that of the three species of Corylus with which it is associated. The dentation of the margin, also, is acute, unequal, partially double, much more like that of the leaves of Corylus than of any of those with which I have compared it.

As is remarked in the description of *C. orbiculata*, a large amount of material has been collected and described since the description of *C. grandifolia* was written, and it has been shown that numerous leaves of Corylus of large size occur in the Tertiary beds of many parts of North America and extend to the European continent. Comparing our specimens with these figures and descriptions, we are led to believe that our *C. grandifolia* is only a large and strong form of *C. MacQuarrii*.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Corylus orbiculata Newb.

Pl. XXXII, fig. 4.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 58; Ills. Cret. and Tert. Pl. (1878), Pl. XV, fig. 4.

"Leaves small, orbicular, or nearly so, slightly and unequally cordate at base, blunt-pointed above; margins set with fine and nearly equal teeth; nervation strong; midrib curved and slightly sinuous; lateral nerves about seven pairs, mostly straight and nearly parallel among themselves, lower pair sending off each seven to eight short, simple or forked branches which terminate in the teeth of the edge; second pair supporting each about three branches of similar character; upper lateral nerves simple, or having each two to three branches near the summit; tertiary nerves parallel, distinct."

Collected by Dr. F. V. Hayden.

This is another hazel-like leaf, of which, without the fruit, the classification must be somewhat doubtful. The general form is more like that of the leaves of Tilia (*T. Americana* and *T. Europæa*), being much rounder than those of any species of Corylus with which I am familiar. The nervation is, however, different from that of Tilia and is, in fact, altogether that of Corylus. In Tilia the leaves are usually broadly cordate; the nervation of the base and lateral portions of the leaf being supplied from the first or basal pair of lateral nerves, which are largely developed, much branched, and reach considerably above the middle point of the lateral margin. In Corylus, on the contrary, the basal nerves are short and supply only the basal margins; the second pair of lateral nerves is relatively more developed than in Tilia, Morus, etc., and in the number and parallelism of the lateral nerves their leaves approach more nearly to the strictly feather-veined leaves of Fagus, Alnus, etc.

Since the above description was written Professor Heer has published his splendid series of volumes on the arctic flora, and has in a number of places made reference to or given figures and descriptions of *Corylus MacQuarrii*, which shows that this was a very variable species, and perhaps the leaf under consideration, to which from its circular form I gave the name *C. orbiculata*, is but one of the numerous varieties of this plant, which seems to have been widely spread over all the North American continent during Tertiary times. Further collections made in the country bordering the

upper Missouri will doubtless supply a larger amount of material illustrating this species, and may prove it to be worthy of recognition as distinct from all others. Taken by itself it presents such striking differences from the other species of Corylus known that it has seemed to me best to give it a distinct name.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Corylus rostrata fossilis Newb.

Pl. XXXII, figs. 1–3.

Corylus rostrata Ait. Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 60; Ills. Cret. and Tert. Pl. (1878), Pl. XV, figs. 1–3.

"These leaves offer no characters by which they can be distinguished from those of the living 'beaked hazel-nut.' They are clearly those of a hazel, and show such a perfect correspondence with those of one of the species living in the region where these fossils occur that, until the fruit shall be found and the question definitely settled, I have thought it best to consider them as identical."

Collected by Dr. F. V. Hayden.

Corylus insignis Heer (Fl. Tert. Helv., Vol. II, p. 43. Pl. LXXIII, figs. 11–17; Fl. Foss. Arct., Vol. II, Abth. IV, p. 469, Pl. XLIX, fig. 5) is closely allied to the plant under consideration, and should perhaps be united with it.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Betula angustifolia Newb.

Pl. XLVI, fig. 5; XLVII, fig. 5.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 508.

"Leaves petioled, oblong-lanceolate, 3 inches long by 1 inch wide; wedge-shaped or slightly rounded at the base, acuminate at summit; margins finely serrate below, coarsely and doubly serrate above; nerves slender, about eight branches on each side of the midrib."

These leaves, of which there are a number in the collection made by Rev. Thomas Condon, are distinguished from the other species of Betula with which they are associated by their narrower and more elongated form

and the coarse, double-crowded dentation of the upper portion of the leaf. They are also separated by these characters from the numerous other species of the genus mentioned by Professor Heer as found in the Tertiary of the northern part of this continent, *B. macrophylla* (Fl. Foss. Arct., Vol. I, p. 146, Pl. XXV, figs. 11–19), *B. prisca* Ett. (Heer, Fl. Foss. Arct., Vol. I, p. 148, Pl. XXV, figs. 20–25; Fl. Foss. Arct., Vol. II, Abth. II, p. 28, Pl. V, figs. 3–7). They bear a closer resemblance to the leaves of *B. ostryæfolia* Sap. (Fl. Foss. Sezanne, p. 345 [57], Pl. XXV [IV], fig. 8), and *B. Sezannensis* Wat. (Pl. Foss. Bass. Paris, p. 130, Pl. XXXIV, fig. 6); but both these species are crenato-dentate, while in the leaves before us the teeth are acute. Among living species this may be compared with *B. lenta* Willd., but is narrower and the marginal dentation is less uniform.

The leaf figured on Pl. XLVII, fig. 5, differs somewhat from those which have been here associated with it, in its more rounded base, coarser dentation below, more open and opposite nervation, and it may represent another species. Part of these differences, however, is probably due to difference in the preservation of the marginal dentation.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Betula heterodonta Newb.

Pl. XLIV, figs. 1–4; XLV, figs. 1, 6.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 508.

"Leaf 2 to 4 inches in length, long petioled, ovate, acuminate, rounded at the base; margins coarsely and irregularly serrate, the principal denticles receiving the terminations of the nerve branches; the sinuses between these sometimes plain, sometimes set with a few small teeth; nervation delicate, about eight branches given off from each side of the midrib."

The collection from Oregon, made by Rev. Thomas Condon, contains a large number of leaves belonging to this species. These present considerable variety in size, as will be seen in the figures. There is also some diversity in the degree of denticulation of the margin. The examples which show this best among those figured are Pl. XLIV, fig. 2; Pl. XLV, fig. 1. Here we see the lateral nerve branches running into prominent teeth of the margin as in many other species of Betula, such as *B. nigra* L., *B. Blancheti* Heer, but the sinuses between these large teeth are sometimes

entire, sometimes bear a few small teeth. The marginal markings are hardly shown in the largest leaf now figured, and it is represented simply to give the form and dimensions, but in the other figures it will be seen that the variation in the dentation is considerable.

In form and general aspect the leaf represented in fig. approaches closely to *B. grandifolia* Ett., as shown by Heer in Fl. Foss. Arct., Vol. II, Abth. II, Pl. V, fig. 8, but the marginal dentation is different. The smaller leaves may in a like manner be compared with Heer's figure of *B. prisca* (*loc. cit.*, fig. 3), but here again the dentation is unlike that of our specimens. It is, however, possible that further observations will lead to the combination of the two species referred to, *B. prisca* and *B. grandifolia*, which are not very unlike with those which occur in such abundance in the locality from which our specimens were derived. The differences, however, are so clearly perceptible that without further information to the contrary the union of these species is not warranted. On Pl. XLV, fig. 6, is represented a samara.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Betula sp.? Newb.

Pl. LVII, fig. 4.

Note.—Marked as above on the margin of the plate by Dr. Newberry. Further information lacking, but locality probably Bridge Creek, Oregon.—A. H.

Alnus Alaskana Newb.

Pl. XLVIII, fig. 8.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 509.

"Leaf large, oblong ovoid, acuminate, rounded, or slightly heart-shaped at base; nervation crowded, sixteen to eighteen branches on each side of the midrib; margins set with very numerous, small, uniform, acute teeth."

We have here a strongly marked species of Alnus, apparently distinct from any hitherto described. Its conspicuous characteristics are its very crowded nervation, the broad, oblong ovoid outline, and the minute and regular serration of the margin. In this latter character it resembles *A. cellulata*, living in eastern North America, but differs in the form of the

leaf and in the greater number of lateral nerve branches. From *A serrata*, figured on Pl. XXXIII of this monograph, it is at once distinguished by the very much finer marginal dentation, as well as by the greater number of nerve branches. The remarkably fine denticulation of the margin is a character which distinguishes it from *A. Kiefersteinii* and *A. nostratum* the species most commonly preserved in the Tertiary rocks.

Formation and locality: Tertiary (Miocene). Kootznahoo Archipelago, latitude 57° 35′, longitude 134° 19′, Alaska. Collected by United States steamer *Saginaw*, February 18, 1869.

Alnus serrata Newb.

Pl. XXXIII, fig. 11.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 55; Ills. Cret. and Tert. Pl. (1878), Pl. XVI, fig. 11.

"Leaves oval or elliptical, slightly cordate at the base, rounded or subacute at summit; margins serrate throughout, serrations fine, sharp, and appressed below, coarse and double above; nervation pinnate, strongly marked; basilar pair of lateral nerves short and simple, upper ones branched near the extremities."

Collected by Dr. F. V. Hayden.

These leaves have nearly the form of *Alnus Kiefersteinii* Ung. (Chlor. Prot., p. 115, Pl. XXXIII, figs. 1–4), and a nervation similar in kind, but more crowded. The marginal serration is also coarser.

Formation and locality: Tertiary (Eocene ?). Banks of Yellowstone River, Montana.

Alnus serrulata fossilis Newb. n. sp.

Pl. XLVI, fig. 6.

Among the leaves from Bridge Creek occurs one very beautifully preserved, which is represented in fig. 6, Pl. XLVI. It will be seen at a glance that it closely resembles the leaves of *A. serrulata*, and I have been unable to find any characters upon which to base a distinction. More material will of course be needed before the fact may be considered established that our most common alder was growing in the Tertiary. There would be nothing surprising, however, in such a discovery; indeed, it was

to be expected that this species, so widespread as it now is, should have some representative in the Tertiary flora. We know that our living flora of North America is the progeny by direct descent of the Tertiary flora, and the result of investigation will undoubtedly be to increase the number of species considered identical in the two floras.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Alnus sp.? Newb.

Pl. XLVI, fig. 7.

Note.—Accompanying this figure, on the margin of the plate, and on the specimen label, are memoranda by Dr. Newberry referring it to this genus and giving the locality. Further information in relation to it is lacking.—A. H.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Alnites grandifolia Newb.

Pl. IV, fig. 2.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 9 (name only); Ills. Cret. and Tert. Pl. (1878), Pl. IV, fig. 2.

Leaf orbicular, with coarsely and obtusely dentate margins; nervation strong, consisting of a straight midrib with six to seven lateral branches, which are nearly opposite and diverge at less than a right angle with each other. Branchlets spring from these on the outer side; several from the lower pair, two from the second pair, which, like the upper of the two given off from each of the third pair, terminate in the dentations of the border. The tertiary nerves which connect the secondary branches are imperfectly parallel, somewhat closely approximate and continuous, forming a more regular lattice work than is formed in any of the associated leaves except those of Protophyllum.

No complete specimens of this strongly marked leaf have as yet been obtained, and nothing but an approximation can be made to its botanical affinities. It is, however, so distinctly marked that it deserves notice if for nothing else than that the attention of collectors may be drawn to it. It has been provisionally placed in the ill-defined genus Alnites, because it bears considerable resemblance to some of the leaves of Alnus, but perhaps quite as much to those of Hamamelis. The existence of closely related

species of the latter genus in the floras of America and Japan gives reason to suppose that this was an element in the old flora which spread from America into Asia and Europe, and therefore gives a probability of its being found in the Tertiary and even Cretaceous flora.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Order FAGACEÆ.

Fagus cretacea Newb.

Pl. I, fig. 3.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 23 (named, but not specifically described); Ills. Cret. and Tert. Pl. (1878), Pl. II, fig. 3.

Leaves 2 to 3 inches in length, ovate in outline, pointed above and below, petioled, nervation sharply defined, regular, lateral nerves parallel, straight below, gently arched above, terminating in the margins, which are sometimes gently undulate, the nerves terminating in the prominences of the margins; in other leaves the margins are quite entire and nothing of this last-mentioned character is seen.

Collected by Dr. F. V. Hayden.

This pretty species is represented in the collection by but a single specimen. This is, however, remarkably well preserved, giving the general form and the details of nervation with great distinctness. From the character of the nervation I have little hesitation in referring it to the genus Fagus. Some of the Rhamnaceæ, particularly species of Rhamnus and Frangula, have leaves which would be very like the one before us if fossilized; but in the fossil plant the lateral nerves are sharply defined, numerous, almost perfectly parallel among themselves, and run quite to the margins, which are seen to be slightly waved, the termini of the nerves being most prominent and the intervals between them forming shallow sinuses. In Rhamnus, however, even in *R. frangula*, of which the leaves so much resemble this, the margins are not waved and the lateral nerves do not terminate as distinctly in them as they do in Fagus and in our fossil.

A striking similarity may be noticed between some of the leaves of the living *Fagus sylvatica*, and this, though there is no probability of that species having begun its life so early in the history of the globe as the first part of the Cretaceous period. The resemblance is noted only as giving good

grounds for the reference of the fossil to the genus Fagus. It will be necessary, however, to find the fruit before the fact can be accepted as fully proven of the existence of beeches during the Cretaceous.

A large number of fossil species of Fagus have been described from the Tertiaries of Europe by Unger, Dunker, Heer, etc., but the genus has never before been obtained from the Cretaceous formation.

Formation and locality: Cretaceous (Dakota group). Smoky Hill, Kansas.

Quercus antiqua Newb.

Pl. XIII, fig. 2.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 26.

"Leaves of medium size, lanceolate in outline, acute, often somewhat flexuous; margins serrate-dentate, with strong, obtuse teeth, which are appressed or turned toward the summit; midrib strong and reaching the apex; lateral nerves numerous, of unequal strength, gently arched upward, terminating in the marginal teeth."

The specimens upon which this description is based are fossilized in a somewhat coarse ferruginous sandstone, which has not preserved the minor details of the nervation; but the generalities of form and structure, which are clearly enough shown, seem to indicate that it represented in the Cretaceous flora the chestnut oaks of the present epoch. Several Tertiary species bear considerable resemblance to it, as *Q. Mediterranea* Ung., and *Q Haidingera* Ett.; but in both these species the marginal dentations are less uniform in size, and, when having a similar outline, are smaller.

Formation and locality: Cretaceous (Dakota group). Banks of Rio Dolores, Utah.

Quercus banksiæfolia Newb.

Pl. XVIII, figs. 2–5.

Bost. Journ. Nat. Hist., Vol. VII (1863), p. 522.

"Leaves very long, linear, lanceolate, long-pointed and acute at either end; margins set with numerous nearly uniform, acute, appressed teeth turned toward the superior extremity; midrib strong, running the entire length of the leaf; lateral veins numerous, simple, strongly marked, parallel, arched upward, terminating in the teeth of the margin; reticulated

nervation buried in the thick parenchyma of the leaf, and generally invisible in the fossil state."

This beautiful leaf resembles, in the style and strength of its nervation, those of the living chestnut oak, but is more slender than any other species, living or fossil, which has come under my observation.

Among described fossil species *Q. Drymeja* Ung. (Chlor. Prot., p. 113, Pl. XXXII, figs. 1–4), *Q. lonchitis* Ung. (Fl. Sotzka, Pl. IX, figs. 3–8), and *Q Saffordi* Lesq. (Geol. Survey of Arkansas, p. 319, Tab. VI, fig. 3) seem to approach it most closely, the former two, indeed, being very nearly allied to it; but in these species the leaves are broader and the lateral nerves are more remote. In *Q. Saffordi* the leaf is, perhaps, equally slender, but the teeth are coarser and less depressed, and the nervation much less strong and regular, resembling in this respect that of the willow oaks (*Q. Phellos*, etc.). The living species with which our plant may be compared are *Q. Xalapensis* and, judging from Professor Heer's description of it, *Q. Sartorii* Liebman. Both of these are from Mexico.

Formation and locality: Cretaceous (Puget Sound group). Chuckanutz, near Bellingham Bay, Washington.

Quercus castanoides Newb.

Pl. LXV, fig. 6.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 506.

"Leaf linear-lanceolate, acute, 6 inches long by 1 inch broad; margins remotely and somewhat irregularly set with coarse, in some cases spinous, teeth; nervation strong; midrib straight, sharply defined; lateral branches unequally spaced, simple, forked near the extremity, terminating in the marginal denticles."

Only imperfect fragments of this leaf are contained in the collection made by Dr. C. A. White, but these are quite sufficient to show the species to be distinct from any other known. The irregularity in the dentation of the margin and in the spacing of the main nerve branches separate this from the chestnuts and bring it within the genus Quercus, and it would seem to be allied to the living and fossil chestnut oaks. More leaves and the fructification will be needed before a complete description can be written, but it is hoped that the figure now given will serve for its recog-

nition, and that since it is plainly different from any of its associates it will be in the future identified and its structure and relations be more fully made out.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Quercus castanopsis Newb.

Pl. LVI, Fig. 4.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 505.

"Leaves oblong-elliptical, rounded at the base; nervation regular; midrib straight, branches parallel, simple, terminating in the principal teeth of the margin; margins doubly dentate, the larger teeth receiving the extremities of the nerve branches, and each carrying a minor denticle; upper surface smooth; texture of the leaf coriaceous."

Collected by Mr. S. M. Rothhammer.

But a single specimen of this leaf is before us, yet this is so peculiar and strongly marked that it seems to deserve description. In general aspect it closely approaches the leaves of Castanea and Fagus, but the margins are doubly dentate, a feature I have not found in any of the beeches or chestnuts. It is present, however, in some of the chestnut oaks, as in *Q. Olafseni* Heer (Fl. Foss Arct., Vol. I, p. 109, Pl. X, fig. 5; XI, figs. 7–11; XLVI, fig. 10). It seems safer, therefore, to refer the leaf to Quercus rather than to the other genera mentioned.

Formation and locality: Tertiary (Eocene?). Yellowstone River, Montana.

Quercus consimilis Newb.

Pl. XLIII, figs. 2–5, 7–10.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 505.

"Leaves petioled, lanceolate, acuminate, wedge-shaped or rounded at base, where they are often unequal; margins usually dentate, occasionally only undulate, sometimes entire below, denticulate above; teeth acute, often spinous, sometimes short and closely appressed; nervation fine and regular; lateral nerves slender, parallel, generally arched upward; below, where margin is entire, camptodrome; above, craspedodrome, the branches terminating in the marginal teeth; tertiary nervation consisting of minute

branches connecting the lateral nerves either directly or anastomosing, with fine quadrangular network filling the intervals. Fruit ovoid; when mature 2 centimeters in length by 15 millimeters in breadth; cupule scaly, covering nearly half of the glans."

Collected by Rev. Thomas Condon.

Of the leaves of this species the collection contains many hundreds which show a considerable diversity of size and form; some are only 2 inches in length, others 6; some have the margin acutely toothed throughout, in others the margin of the lower part of the leaf is entire, the upper denticulate; while in others still the margins are entire or gently undulate to near the summit where they are always more or less denticulate. These leaves closely resemble those that have been described under the name of *Q. Drymeja* Ung. (Chlor. Prot., p. 113, Pl. XXXII, figs. 1–4; Foss. Fl. Sotzka, p. 163 [33], Pl. XXIX [VIII], figs. 1, 2; Heer, Fl. Tert. Helv., Vol. II, p. 50, Pl. LXXV, figs. 18–20), and also some of them, those in which the margins are closely and sharply denticulate, are not unlike *Q. lonchitis* Ung. (Foss. Fl. Sotzka, p. 33, Pl. IX [XXX], figs. 3–8), but the prevailing character is such as apparently distinguishes them from either of these species or any other described, namely, first, the base broader than in *Q. Drymeja*, frequently entire for one-third or one-half of the length of the leaf; second, the margins generally denticulate, but sometimes merely undulate or entire except near the summit—a range of variation which does not seem to prevail in the species named.

In the figures given on Pl. XLIII, fig. 2 represents the more common or average form and size, figs. 3, 4, and 5 the more denticulate variety. In order to make the series complete it would have been necessary to occupy the entire plate with representations of the different forms observable in the collection. In many of the specimens the preservation is complete, the outlines being sharply defined, the minutest subdivisions of the nerves being retained. The number of acorns and cupules contained in the collection is also large, and while it is possible that not all belong to this species, as it is by far the most abundant we are compelled to connect the abundant acorns with the numerous leaves. In fig. 7 an immature acorn is shown still attached to the stem; in fig. 8, a detached cupule; in fig. 9, the base of a large acorn; in fig. 10, a large cupule seen from above.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Quercus coriacea Newb.

Pl. XIX, figs. 1–3; XX, fig. 5.

Bost. Journ. Nat. Hist., Vol. VII (1863), p. 521.

"Leaves lanceolate, long-pointed, acute, wedge-shaped at base, decurrent on the petiole; margins entire, or rarely bearing a few acute teeth toward the summit; nervation strongly marked; midrib strong; lateral nerves numerous, subparallel, branching and inosculating at the summit."

This is one of the willow oaks represented among recent species by *Q. imbricaria*, etc.

The figures given illustrate the variations of form exhibited in the collection. From these it will be seen that, with the general character of *Q. chlorophylla* Ung. and *Q. elæna* Ung., it is distinct from both, the first being rounded above and with finer nerves, the second larger and narrower, with a nervation finer and closer and the summits of the lateral nerves more distinctly and regularly united.

Formation and locality: Cretaceous (Puget Sound group). Chuckanutz, near Bellingham Bay, Washington.

Quercus dubia Newb.

Pl. XXXVII, fig. 5.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 506; Ills. Cret. and Tert. Pl., (1878), Pl. XX, fig. 5, under *Phyllites cupanioides*.

"Leaf ovoid in outline, unsymmetrical; margins strongly and remotely toothed; teeth subacute or obtuse; nervation delicate; midrib flexuous; lateral branches, about six on a side, somewhat waved, branched, and interlocking, and terminating in the marginal denticles; surface smooth, consistence probably somewhat coriaceous."

Collected by Dr. F. V. Hayden.

This is a strongly marked leaf which most resembles that of some of the live oaks. The texture was evidently leathery, the surface smooth; the nervation is that of Quercus or Ilex, as well as the marginal dentation. The species with which it may be compared are *Q. aspera* Ung. (Chlor. Prot., p. 108, Pl. XXX, figs. 1–3), *Q. Buchii* Web. (Palæontogr. (1852), p. 171 [57], Pl. XIX [II], fig. 4), and *Q. ilicoides* Heer (Fl. Tert. Helv., Vol. II,

p. 55, Pl. LXXVII, fig. 16); but from all these it may be distinguished by its coarse, generally obtuse, marginal denticles.

Formation and locality: Tertiary (Eocene?). Tongue River, Montana.

Quercus elliptica Newb.

Pl. XVIII, fig. 1; XX, fig. 3.

Bost. Journ. Nat. Hist., Vol. VII (1863), p. 523.

"Leaves elliptical or ovate, rounded or somewhat wedge-shaped at base, pointed above; margins entire. Surface smooth, consistence thick and leathery; nervation strong; lateral nerves numerous, diverging at a large angle, slightly arched upward, often sinuous, forked and anastomosing above."

In its nervation this species resembles several of the laurel-leaved oaks already described from the Tertiary rocks of Europe, such as *Q. nereifolia*, *Q. Heerii*, *Q. elaena*, etc., but is distinguishable from all these and other otherwise similar species by its broad elliptical or ovate outline. The margins in the specimens before us are apparently entire, but they are probably sometimes toothed, as in most allied species.

Formation and locality: Cretaceous (Puget Sound group). Chuckanutz, near Bellingham Bay, Washington.

Quercus flexuosa Newb.

Pl. XIX, figs. 4–6.

Bost. Journ. Nat. Hist., Vol. VII (1863), p. 521.

"Leaves 4 to 6 inches long, lanceolate, often more or less curved, pointed, acute, narrowed at the base to the petiole; margins somewhat irregularly sinuate-dentate; nervation strongly marked, lateral nerves forked and anastomosing at the summit."

This is apparently one of the chesnut oaks, but has not the regularity of nervation which characterizes most of that group, of which *Q. castanea* may be taken as a type.

Among fossil species there are many to which it bears considerable resemblance, such as *Q. Gaudini* Lesq., *Q. Gmelini* Ung. *Q. urophylla* Ung., etc., but from these and all others described it seems to be sufficiently distinct. In *Q. Gaudini* the secondary nerves are curved and run along

the margins. In the other species mentioned they are less numerous and more curved and the marginal teeth are coarser.

Formation and locality: Cretaceous (Puget Sound group). Chuckanutz, near Bellingham Bay, Washington.

Quercus gracilis Newb.

Pl. LXVII, fig. 4.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 504.

"Leaves narrow, lanceolate, long-pointed, acute, wedge-shaped at the base; margins set with remote, low, acute teeth; nervation regular and fine; nerve branches fifteen to twenty on each side, curved gently upward, and terminating in the marginal teeth."

Collected by Dr. J. S. Newberry.

This is another of the lanceolate, serrate-leaved oaks of which *Q. Drymeja* Ung. (Chlor. Protog., p. 113, Pl. XXXII, figs. 1–4) may be considered as a type. It differs from that species, however, in its more crowded nervation, smaller teeth, and shallower sinuses.

In the figure given the nervation is represented as too strong, and the marginal teeth are not sufficiently acute. Several very beautifully preserved specimens are before us, which give a very exact and complete view of it, and its resemblance to *Q. Drymeja* is so strong that if it had occurred in the same horizon and locality there would have been no propriety in separating them; but in addition to the differences that have been mentioned, the geological horizons are so different that the probability of finding any identity of species is extremely small. For the present, therefore, it has been thought best to regard this as distinct from the great number of leaves that have been in North America and Europe referred to *Q. Drymeja*.

Formation and locality: Cretaceous (Montana group). Point of Rocks, Wyoming.

Quercus Grönlandica Heer.

Pl. LI, fig. 3, in part; LIV, figs. 1, 2.

Fl. Foss. Arct., Vol. I (1868), p. 108, Pl. VIII, fig. 8; X, figs. 3, 4; XI, fig. 4; XLVII, fig. 1.

Note.—So identified by Dr. Newberry, as indicated by memorandum on the margin of the plate and on specimen label.—A. H.

Formation and locality: Tertiary (Miocene). Cook Inlet, Alaska.

Quercus laurifolia Newb.

Pl. LIX, fig. 4; LX, fig. 3.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 505.

"Leaves petioled, lanceolate, 6 inches in length by 1½ inches in width, equally narrowed to the point and petiole; margins entire, or faintly toothed, or undulate; nervation regular; midrib strong, straight, lateral branches, about ten pairs, arching gently upward, terminating in the margins."

Collected by S. M. Rothhammer, on the expedition of Gen. Alfred Sully.

Although reluctant to add one more to the large number of ill-defined species of oak which have been established upon the fossil leaves brought from the far west, this seems to be inevitable, inasmuch as the leaves before us are in all probability those of Quercus and distinct from any hitherto described. The most striking feature in these leaves is their elegant lanceolate and symmetrical form, broadest in the middle and narrowing regularly to the pointed base and summit. The craspedodrome nervation and the undulate or faintly toothed margins seem to separate these leaves from Laurus and connect them with the oaks. The figures given but imperfectly represent the leaves in question, but it is hoped that the description will permit their identification when found.

Formation and locality: Tertiary (Eocene?). Burned shales over lignite beds, Fort Berthold, Dakota.

Quercus paucidentata Newb.

Pl. XLIII, fig. 1.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 505.

"Leaves oblanceolate, 6 inches in length by 1½ in breadth, narrowed to the base, sometimes unsymmetrical, long-pointed, and acute at the summit; margins entire below, coarsely toothed above; nervation strong and regular, about ten branches on each side of the midrib, which curve upward, festooned below, terminating in the teeth above."

Collected by Rev. Thomas Condon.

No complete specimens of these leaves are contained in the collection,

the one figured being the best. The texture was evidently thick and leathery. The apex is erroneously represented in the figure, as subsequent development of the specimen shows that it terminates in a long-drawn acute point. Among described species this may be compared with *Q. Nimrodis* Ung. (Foss. Fl. Sotzka, p. 163 [33], Pl. XXXI [X], figs. 1–3), and *Q. Meriani* Heer (Fl. Tert. Helv., Vol. II, p. 53, Pl. LXXVI, fig. 12), but in those species the marginal teeth are stronger and are not, as in this, confined to the summit. The substance of the leaf of the specimens before us was evidently very thick and leathery.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Quercus salicifolia Newb.

Pl. I, fig. 1.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 24; Ills. Cret. and Tert. Pl. (1878), Pl. II, fig. 1.

"Leaves petiolate, smooth, thick, entire, lanceolate, abruptly pointed at both ends; medial nerve strong, straight, or more or less curved; secondary nerves of unequal size, strong near their points of origin, becoming fine, flexuous, and branching as they approach the margins of the leaf, where some of them inosculate by irregular curves, while others terminate in the margins."

Collected by Dr. F. V. Hayden.

This species differs considerably in its general aspect from the willow-like leaves with which it is associated, and must have been much thicker and smoother. The midrib is very strong, terminating below in a thick, but short, petiole. The lateral nerves are much less uniform and regular than those of the leaves to which I have referred. They are at first strong, but soon diminish, and many of them extend but halfway to the margin, the others being unequally curved and branching irregularly or anastomosing with each other. The finer details of nervation are not given in the specimens before me, and perhaps more ample material will show that our fossil should not be regarded as a Quercus, but, as far as its characters are given, they agree best with those of that genus. The texture of the leaf was evidently thick and its surface glossy, more so than in any Salix now living; the nervation, too, is more of the oaks than willows; the alternation of larger with smaller secondary nerves, all

diminishing rapidly and irregularly branched and flexuous above, are characters common to the leaves of all the willow-oaks. Some leaves of the living *Q. imbricaria* would closely resemble these if fossilized in the same manner. In the Lauraceæ with lanceolate leaves the nervation is generally much more exact and regular than in the specimen before us, the side nerves being generally curved gracefully and more or less uniformly upward, their extremities anastomosing, or, more rarely, reaching the margin. If the fine reticulation of the tertiary nerves was distinctly visible there would perhaps be little difficulty in determining with a good degree of certainty the generic relations of this fossil. In the oaks this reticulation is very fine, the areolæ of rather uniform size and quadrangular or polygonal, about as broad as long. In the willows the meshes are larger, more irregular, and more or less elongated.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Quercus simplex Newb.

Pl. XLIII, fig. 6.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 505.

"Leaves lanceolate, long-pointed, narrowed, and slightly rounded at the base; margins entire; nervation fine and regular."

In collections made by Rev. Thomas Condon at Bridge Creek, Oregon, are numerous leaves similar to that described above. Some are larger, but all present the same characters. The form of the leaf is similar to that of *Q. consimilis*, with which it is associated and from which it differs only by its entire margin. Since in that species the margins are sometimes nearly entire, it is possible that in the leaves before us that character may be intensified, giving an entire variety. Of this, however, proof can only be obtained by further collections.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Quercus sinuata Newb.

Pl. XIII, fig. 1.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 27.

"Leaves small, obovate in general outline, narrowed to the petiole, or slightly decurrent; margins deeply lobed, lobes rounded, broader than the

sinuses that separate them, three nearly equal on either side, summit broadly rounded or obscurely lobed, often oblique; nervation strong and simple, midrib straight or slightly flexed, giving off lateral branches, which run to the margins of each lateral lobe."

The general form of this leaf is much like that of our living *Q. obtusiloba*, though it is smaller and more symmetrical. Among the many fossil species which have been described there is none which approaches this very closely, most of them bearing either simple, entire leaves, or toothed, rather than lobed ones.

Formation and locality: Cretaceous (Dakota group). Banks of Rio Dolores, Utah.

Quercus Sullyi Newb.

Pl. LX, fig. 2.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 506.

"Leaves ovate, pointed, wedge-shaped, or rounded at the base; margins set remotely or closely, with acute, spiny-pointed teeth; nervation strong, somewhat flexuous; lower pair of lateral nerves giving off numerous branches; middle and upper pairs simple below, forked at the summit."

Collected by S. M. Rothhammer, on the expedition of Gen. Alfred Sully.

The characteristics of these leaves are but imperfectly shown in the figure, but the general form, margin, and nervation can be very well made out from the numerous fragments contained in the collection made by the Sully Expedition. It is evident that we have here one of the Ilex-like oaks, and indeed it may be a question whether it is not rather a holly than an oak. The leaf was generally unsymmetrical, the nervation strong but flexuous, the surface roughened by the tertiary nerve branches. In a general way these leaves resemble those of the common evergreen oak, *Quercus agrifolia* of California, but the spines of the margin are smaller and more numerous, the leaves more elongate and pointed. It is evident, however, that the tree which bore them belonged to the same group of oaks.

Formation and locality: Tertiary (Eocene?). Burned shales over lignite beds, Fort Berthold, Dakota.

Order ULMACEÆ.

Ulmus speciosa Newb.

Pl. XLV, figs. 2–5, 7, 8.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 507.
Ulmus pseudo-Americana Lesq., Cret. and Tert. Fl. (1883), p. 249, Pl. LIV, fig. 10.

"Leaves 4 to 6 inches in length by 2 inches in width, petioled, long-ovoid, or elliptical in outline, pointed at summit; margins coarsely and doubly serrate; nervation strong, regular, fifteen to twenty parallel branches one either side of midrib. Fruit large, 27 centimeters in diameter, subcircular, emarginate."

This large and fine species of elm is represented by hundreds of specimens in the collection made by Rev. Thomas Condon, and while most are imperfectly preserved, there are some which show all the details of form and structure. The general aspect of the leaves is not unlike that of *U. Bronnii* Ung. (Chlor. Prot., p. 100, Pl. XXVI, figs. 1–3), but is fully twice as large and coarsely and doubly serrate.

The leaf represented by fig. 8 is one of many which occur in the collection, all presenting nearly the same character; that is, they are smaller than those just described, with much finer marginal dentation. That dentation is, however, double and like that of the larger leaves, though less pronounced, and there are no characters presented by these leaves which would justify us in regarding them as representing a distinct species. For the present, therefore, it has been thought better to leave these as small forms of *U. speciosa.*

Among living species *U. fulva* approaches closer to those now under consideration than any other, and the differences between the fossil and living forms are not so great but that we may very well regard one as the progenitor of the other. In *U. fulva* the leaves are smaller and relatively broader, being ovoid in outline, but the character of the marginal dentation and of the nervation is essentially the same.

The samara, represented by fig. 7, is supposed to be the fruit of the large elm described above. It is very similar in size and character to the fruit credited to *U. Bronnii* by Ung., but is somewhat broader. It has not yet been distinctly connected with the leaves we have called *U. speciosa,*

but there seems to have been no other tree growing in the locality where these specimens are found of which this could well be the fruit.

The fruit of *U. fulva* has nearly the same form as this, but is only about half as large, while the fruit of *U. Americana* is still smaller and is obovoid and cilliated.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Planera crenata Newb.

Pl. LVII, fig. 3.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 508.

"Leaves oblong, ovate; short petioled; 5 centimeters long by 25 millimeters wide; base rounded; summit blunt-pointed; margins coarsely crenate; nervation simple, delicate, six simple branches on each side of the midrib terminating in the crenations of the margin."

Collected by Dr. F. V. Hayden.

In general aspect these leaves resemble some of the varieties of *P. Ungeri,* but differ from them in the crenate margins, the lobes being fewer and all rounded. In these respects it differs also from the species described in this volume, *P. longifolia* Lesq. (Pl. LVIII, fig. 3), *P. variabilis* Newb. (Pl. LXVI, figs. 5, 6, 7), and *P. nervosa* Newb. (Pl. LXVII, figs. 2, 3).

Formation and locality: Tertiary (Eocene ?). Tongue River, Montana.

Planera longifolia Lesq.

Pl. LVIII, fig. 3.

Hayden's Ann. Rept., 1872 [1873], p. 371; Tert. Fl. (1878), p. 189, Pl. XXVII, figs. 4–6.

Note.—So identified and located by Dr. Newberry, as indicated by memorandum on margin of plate. Further information lacking.—A. H.

Formation and locality: Tertiary (Miocene). Florissant, Colorado.

Planera microphylla Newb

Pl. XXXIII, figs. 3, 4.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 55; Ills. Cret. and Tert. Pl. (1878), Pl. XVI, figs. 3, 4.

"Leaves very small, ovate-lanceolate, generally unsymmetrical, curved or falcate, cordate at base, pointed but rarely acute, coarsely and bluntly

toothed; nervation strong; lateral nerves diverging at an angle of about 50 degrees in five to six pairs branching toward the summit, and inosculating along the margins; tertiary nerves strong, leaving the secondaries nearly at right angles, much branched and anastomosing to form a coarse and irregular network."

Collected by Dr. F. V. Hayden.

In its general form this leaf has a striking resemblance to *Planera Ungeri* Ett. (Abhandl. k. k. geolog. Reichsanstalt. Wien, Vol. II (1851), Foss. Fl. Wien, p. 14, Pl. II, figs. 5–18), *Ulmus Zelkovæfolia* Ung. (Chlor. Prot., p. 94, Pl. XXIV, figs. 7–13; XXVI, figs. 7, 8), but it is apparently considerably smaller, narrower, and more coarsely toothed.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Planera nervosa Newb.

Pl. LXVII, figs. 2, 3.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 508.

"Leaves ovate or lanceolate, pointed, wedge-shaped, or rounded at the base, petioled; margins set with coarse, appressed teeth; nervation strong, crowded, regular; lateral nerves simple, parallel, terminating in the teeth of the margins."

Collected by Dr. C. A. White.

The most striking feature in these leaves is their strong, crowded, regular nervation, from thirteen to nineteen nearly equidistant simple nerve branches issuing from either side of the midrib. The nervation is equally regular in *P. longifolia*, Lesq., Tert. Fl., p. 189, Pl. XXVII, figs. 4–6; this volume, p. 81, Pl. LVIII, fig. 3, but is lighter, and the marginal dentation is coarser, the teeth more obtuse.

Fig. 4, on Lesquereux's plate cited above, resembles more the leaves before us and apparently belongs to a species distinct from the other two leaves with which it is there associated, possibly to this one. The leaves of *P. longifolia* are found in great abundance at Florissant, Colorado, and they are so much alike that there is no difficulty in separating them from other described species; while in the localities where the leaves of *P. nervosa* occur there are none which have the few long, horizontally cut teeth of *P. longifolia*. Hence while there is considerable resemblance in

the general aspect of these leaves, there can be little question that they are specifically distinct.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Planera variabilis Newb.

Pl. LXVI, fig. 5–7.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 508.

"Leaves lanceolate, to broad ovate; usually unsymmetrical, petioled; summit acute, sometimes long-pointed; base rounded or wedge-shaped; margins coarsely crenulate-dentate or serrate, with remote, appressed teeth; midrib straight, strong; lateral nerves delicate, frequently alternating stronger and finer, gently arched upward, terminating in the teeth of the border; the finer intermediate ones sometimes fading out before reaching the margin."

Collected by Dr. C. A. White.

Some of the various forms of leaves ascribed to *Planera Ungeri* fairly represent those before us, and their generic resemblance is apparent; but in our plant the leaf is more pointed, the serratures are coarser, generally more obtuse, and, when acute, more appressed.

Planera longifolia Lesq., has larger, more symmetrical, and less acute leaves, with coarser triangular teeth. (See Pl. LVIII, fig. 3.)

From the other species described in this volume this may be distinguished by its greater size, more ovate form, coarser serrations, and relatively smaller crenations. *Planera emarginata* Heer (Fl. Tert. Helv., Vol. II, p. 61, Pl. LXXIX, fig. 24) has much more acute teeth and more bristling aspect.

Several figures have been given of this species, in order to show the diversity of form it assumes, and it could be easily imagined that they were specifically different; but coming as they do from one locality, and in the large collections made from this, we have an unbroken series, all pervaded by a similarity of aspect, we must conclude that they are all from one kind of tree. Possibly future collections will prove that the narrower, more rigid form, with the deeply cut and acute serrations, and parallel, nearly straight lateral veins, shown in fig. 7, belongs to a different species; but in the very large number of Planera leaves before me it is impossible

to make any division without making several. They are, therefore, all grouped together for the present.

Formation and locality: Tertiary (Green River group). Green River Station, Wyoming.

CELTIS PARVIFOLIA Newb.

Pl. LIII, fig. 6.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 510.

"Leaves small; oblong-ovate in outline; rounded and unsymmetrical at the base, pointed at the summit; margins, except at the base, coarsely dentate; nervation sparse; two principal branches on each side of midrib, one pair springing from the base and throwing off branchlets, another strong pair issuing from the midrib at the middle of the leaf, other delicate branches given off near the summit."

Collected by Dr. F. V. Hayden.

In its general aspect, as well as its details of structure, this leaf very closely resembles *C. Australis*, differing from our living *C. occidentalis*, as well as from the fossil species that are found in the Tertiary beds of this country by its simpler nervation, its smaller size, and the relatively coarser serration of the margin.

Formation and locality: Tertiary (Eocene?). Tongue River, Montana.

Order MORACEÆ.

FICUS (?) ALASKANA Newb.

Pl. LI, fig. 1; LII, fig. 1; LV, figs. 1, 2.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 512.

"Leaves large, reaching 8 to 10 inches in length and breadth; trilobed, generally unsymmetrical; lobes pointed, usually obtuse; margins entire or locally undulate; nervation strong, conspicuously reticulate; principal nerves, three, giving off branches, which divide near the margins, sometimes connecting in festoons, sometimes craspedodrome; tertiary nervation forming a coarse network of usually oblong meshes filled with a fine polygonal reticulation; upper surface of the leaf smooth and polished, lower roughened by the reticulation of the nerves."

Collected by Captain Howard, U. S. N.

These beautiful leaves have been referred with much doubt to Ficus. They present considerable resemblance to some of the leaves of *Ficus*

tiliæfolia Heer, particularly the lobed form shown in Fl. Tert. Helv., Vol. III, p. 183, Pl. CLII, fig. 14, and the nervation is sometimes similar, though generally less distinctly camptodrome. The differences, however, between our leaves and the usually simple unsymmetrical obliquely based leaves of *T. tiliæfolia* show specific and perhaps generic distinctness. The localities which furnished the specimens now figured show by the great abundance of leaf impressions brought from there that they were at one time the home of rich and luxuriant vegetation, the slabs which carry these leaves being crowded with those of many different genera and species closely impacted together. Among these are the great oak leaves, 1 foot to 15 inches in length and 6 inches in width (*Q. Grönlandica*), *Taxodium distichum miocenum*, *Juglans nigella*, *Prunus variabilis*, large leaves of *Platanus* and *Pterospermites*, *Corylus MacQuarrii*, etc. This Ficus (?) seems to have been as abundant as any other, and collectors who shall visit the locality hereafter, by taking proper pains, will be able to find abundant and satisfactory representatives of all these and many other plants, and will undoubtedly obtain conclusive evidence of their botanical relations.

Formation and locality: Tertiary (Miocene). Cook Inlet and Admiralty Inlet, Alaska.

Ficus asarifolia minor Lesq.

Pl. LXVII, figs. 5, 6.

Hayden's Ann. Rept., 1874 [1876], p. 303; Tert. Fl. (1878), p. 208. Not *F. asarifolia* Ett., Fl. Bilin., p. 156, Pl. XXV, figs. 2, 3, 6.

Note.—These specimens unquestionably represent the variety of the species referred by Lesquereux to *F. asarifolia* Ett. in Hayden's Annual Report, 1874 [1876], p. 303; but this species has serrated margins, while in ours the margins are entire or slightly undulate. This distinction was recognized by Dr. Newberry in a memorandum on the plate, but he failed to state what name he intended to give to the American leaves.—A. H.

Formation and locality: Cretaceous (Montana group). Point of Rocks, Wyoming.

Ficus (?) Condoni Newb.

Pl. LVI, fig. 1; LVII, fig. 1; LVIII, fig. 1.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 512.

"Leaves large, sometimes nearly 2 feet in length, three to five-lobed, slightly decurrent, and the petiole sometimes stipulate; margins entire, or

gently undulate; nervation very strongly marked and closely reticulate, roughening the surface, camptodrome, but nerve branches sometimes terminating in the margins of the middle lobe."

Collected by Rev. Thomas Condon, to whom the species is dedicated as a recognition of the important contribution he has made to paleontology in the discovery and exploitation of these interesting plant beds.

The remains of this remarkable plant occur in great abundance in the Bridge Creek Tertiary beds, and it is represented in the collections made there by a large number of specimens. Some of these indicate leaves 18 inches to 2 feet in length and nearly as much in breadth. The most striking feature which they exhibit after their great size is the marked reticulation of the surface, which has given a peculiar lacelike roughening to the rock in the leaf impression. This character, as well as the general form and nerve structure, is fairly well given in the figures, and no one having seen them will have difficulty in recognizing the fossil.

The reference to the genus Ficus wants the confirmation of the fruit before it can be accepted as established, but among all the leaves with which these have been compared there are none to which they bear so great resemblance as to those of the Moraceæ, and especially with those of the leaves of Ficus and Artocarpus. The nervation is strikingly like that of a number of species of Ficus, such as *F. scabriuscula*, *F. oppositifolia*, *F. Roxburghiana*, *F. sycomorus*, and perhaps to none more than to that of the common fig, *F. Carica*. Hence, with regret in adding to the already large number of ill-defined fossil species of Ficus, it has seemed best to provisionally refer these leaves to that genus, giving them a place to which, without the evidence of the fruit, they are apparently as much entitled as any others. Sometime the fructification will be found, and then all doubt will be set at rest. There is good evidence that the genus Ficus was well represented in the luxuriant, warm temperate or subtropical flora which prevailed over so much of North America during the Tertiary age, as it is now in the forests of tropical and subtropical America. At the same time it is necessary to say that of the large number of species of Ficus more than 20, which have been described as occurring in our Tertiary rocks, the identification has been in many instances based upon evidence that must be regarded as unsatisfactory.

One of the most striking characters of these leaves is formed by the

reflexed stipule-like lobe at the base of the leaf. This is a feature that it has in common with some species of Platanus, especially *Platanus basilobata* Ward (Synopsis, Flora Laramie Group, 6th Ann. Rept. U. S. Geol. Surv. for 1884–85 [1886], Pls. XLII, XLIII), and something of the kind is frequently found in strong growing shoots of the living *Platanus occidentalis*. As I have said in my description of *Platanus nobilis*, there are some characters in the leaves of that tree which raise the question whether it was a true Platanus, and yet my reference of it to that genus has been confirmed by Sir William Dawson and Dr. Lester F. Ward. The former has found leaves which he considers those of *P. nobilis* having this basilar lobe, and he has suggested that Dr. Ward's *P. basilobata* should be named *P. nobilis* var. *basilobata*. I should not be surprised if, in the light of more material, *P. nobilis* and the species now under consideration should be united in a new genus; but without additional material such a step would be hardly wise.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Ficus membranacea Newb.

Pl. LIX, fig. 2.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 512.

"Leaves sessile, 4 to 6 inches in length, by 2½ to 3½ in width; ovate, abruptly and usually blunt-pointed, narrowed to the base, generally unsymmetrical, margin entire, nervation delicate, open, camptodrome; ten or more branches given off on either side of the midrib, curving upward, and forming a festoon near the margin."

Of these leaves there are quite a number in the collection from Alaska, made by Captain Howard, and such as exhibit considerable diversity of form, as will be seen by the figures. That shown on Pl. LIX is imperfect and imperfectly represented; it is smaller than the average and more pointed, and the base should be prolonged and narrowed. The reference of these leaves to Ficus is provisional and can not be insisted upon. The nervation is that of this genus, and a considerable resemblance is shown to those described by Lesquereux (Tert. Fl., p. 194, Pl. XXVIII, figs. 9–12) under the name of *F. oblanceolata*, but they are larger, broader in form, and the nervation is much more open. The texture of these leaves was evidently thin and membranous, a character plainly shown by

the contrast in appearance which they present to oaks, poplars, prunes, etc., with which they are associated; this is also indicated by the delicate, open, and flexuous nervation.

Formation and locality: Tertiary (Miocene). Cook Inlet, Alaska.

Ficus planicostata Lesq.?

Pl. XLVI, fig. 1.

Hayden's Ann. Rept., 1872 [1873], p. 393; Tert. Fl. (1878), p. 201, Pl. XXXI, figs. 1–8, 10–12.

The leaf here figured is hardly sufficient for satisfactory determination; it is imperfect at the summit and throughout part of the margin; however, the insertion of the petiole and the nervation give it characters which are separated widely from any other leaves with which it is associated in the collection. The petiole is broad, and is inserted obliquely in the base of the leaf. The nervation is beautifully camptodrome, the branches of the basal pair of lateral nerves, as well as the summits of the lateral nerves above, forming a most beautiful and regular festoon. This is essentially the nervation of *F. planicostata*, and although the specimen is much smaller and narrower than the average of the leaves ascribed to that species, I have thought best to refer it doubtfully to this place until further material will permit the definitive settlement of the question.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Ficus reticulata (Lesq.) Hollick.

Pl. XII, figs. 2, 3.

Laurophyllum reticulatum Lesq. Hayden's Ann. Rept. 1872 [1873], p. 425; Cret. Fl. (1874), p. 76, Pl. XV, figs. 4, 5.
Ficus laurophyllum Lesq. Hayden's Ann. Rept. 1874 [1876], p. 342, Pl. V, fig. 7.
Ficus laurophylla Lesq. Cret. and Tert. Fl. (1883), p. 49, Pl. I, figs. 12, 13.

Quite a number of specimens of these very distinctly marked leaves are contained in the collection received from Mr. Sternberg from Fort Harker, and still larger and finer ones since obtained through other channels show that the leaves sometimes attained a size considerably greater than that represented in fig. 2, but it was as wide and much longer. All these are alike in showing a smooth and polished surface, a thick, leathery texture,

a remarkably strong, straight, smooth midrib; pinnate, delicate, irregularly spaced, branched camptrodome lateral nerves. Except that they are more lanceolate and pointed, these leaves would hardly be distinguishable from those of *Ficus elastica* if fossilized. In form, exactness of outline, and strength of midrib, they resemble the leaves of Nerium, but the nervation is quite different.

Formation and locality: Cretaceous (Dakota group). Fort Harker, Kansas, and Blackbird Hill, Nebraska.

Protoficus inæqualis Newb.

Pl. LVIII, fig. 2; LX, fig. 1.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 512.

"Leaves 4 to 5 inches long, by 3 inches wide; oval, pointed at the summit, narrowed and rounded at the unsymmetrical base; margins entire or in part undulate; nervation strongly defined but open; about seven branches on each side of the midrib, the lower two or three giving off branches below, the upper simple, arched upward, terminating in the margin, the intervals between the branches spanned by numerous, generally simple tertiary nerves."

Collected by Dr. F. V. Hayden.

The general aspect of these beautiful leaves is not well given in the figure. They seem to have been thick and polished above, roughened below by the strongly marked nervation. They resemble in many respects the leaves of Protoficus, described by Count Saporta, from the travertines of Sezanne, as will be seen by comparing his figure of *Protoficus crenulata* (Fl. Foss. Sezanne, p 67, Pl. VI, fig. 5). Our leaves differ from that, however, in this, that the base is unsymmetrical, the margin is entire or undulate, and the nervation is craspedodrome. This latter character is not common, but is not unprecedented among the figs, the leaves of several species of which bear considerable resemblance to these, e. g., *F. sycomorus*.

It will also be noticed that the leaves under consideration are not unlike those described by Lesquereux under the name of *Ficus planicostata* var. *Goldiana* (Tert. Fl., p. 202, Pl. XXXIII, figs. 1–3), but differ from them in the inequality of the base and the details of nervation. It seems highly probable, however, that they should form species of the same genus.

Formation and locality: Tertiary (Eocene?). Tongue River, Montana.

Order ARISTOLOCHIACEÆ.

Aristolochia cordifolia Newb.

Pl. XXXIX; XL, fig. 7; LX, fig. 4.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 74; Ills. Cret. and Tert. Pl. (1878), Pl. XXII, under *Catalpa crassifolia;* XXV, fig. 7.
Catalpa crassifolia Newb. Op. cit., p. 56.

"Leaves large, fleshy, ovate, heart-shaped at base, pointed above, sometimes unsymmetrical; margins entire; nervation strongly developed; midrib straight or flexuous; lateral nerves about seven pairs; lower pair strongest, not reaching the middle of the leaf, giving off each about four branches on the lower side, of which the lower ones spring from the base of the laterals and are much branched; upper laterals branched at their summits, branches uniting to form a festoon somewhat remote from the margin; tertiary nervation invisible."

Collected by Dr. F. V. Hayden.

These leaves are referred in the Annual Report of the New York Lyceum of Natural History with hesitation to Catalpa, which they considerably resemble in form and nervation; but a large number of specimens submitted to inspection since the description was written exhibit characters which lead me to suspect that they represent a species of Aristolochia. This additional material shows the leaves to have been sometimes very large, more than 1 foot in diameter, broadly cordate in outline, often unsymmetrical. Fig. 4, given on Pl. LX, exhibits the broader and more rounded form and the open festooned nervation; but this is scarcely more than one-third of the linear dimensions of the largest. The texture of the leaf seems to have been very thin, the nervation is sparse and open, though the principal nerves must have been somewhat fleshy. There are also associated with these leaves slender tortuous stems that seem to be portions of a vine. Taking these facts into consideration, I have been led to refer these leaves to Aristolochia and to compare them with the large, broadly cordate leaves of *A. sipho.* Future collections will undoubtedly furnish material which will render it possible to speak with confidence in regard to the generic relations of the plant.

Formation and locality: Tertiary (Eocene?). Banks of Amil Creek, Dakota.

Order NYMPHÆACEÆ.

CABOMBA(?) GRACILIS, Newb.

Pl. XXII, fig. 1; XXIII, fig. 1.

Cabomba gracilis Newb. Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 514. Ills. Cret. and Tert. Pl. (1878), Pl. VII, fig. 1, under "aquatic rootlets of Equisetum"; VIII, fig. 2, under "Equisetum."

"Stem slender, smooth; submerged leaves set at intervals of half an inch to an inch apart on the stem, opposite dichotomously and frequently branched, segments narrowly linear, or filiform, flattened, smooth, truncated, scarcely distinguishable from the stem and leaves of *C. Caroliniana*."

A large number of intertwining, smooth, narrow stems, with opposite, many-forked, linear leaves, are contained in some of the collections made from the Tertiary beds of the upper Missouri by Dr. F. V. Hayden. They were at first regarded as aquatic rootlets, but an examination of a multitude of well-preserved specimens shows that they are leaves and not roots, and comparing them with living plants they are found to imitate with a most perfect exactness the stems of leaves of Cabomba. The smaller specimens, like that figured, accurately represent the filiform variety of *Cabomba Caroliniana* of our Southern States. Mingled with these stems and leaves are obscure fragments of what may have been the peltate leaves, since some of them show a sort of umbilicus as though the point of attachment of the stem. Had there been but one or two of these specimens corresponding to the above description, their nature would have been left in so much doubt as to render it unwise to call attention to them; but occurring as they do in connection with other aquatic plants in very large numbers, and having a definite and invariable character, the stems smooth and lacking all the characteristics of creeping root stalks or aquatic roots, the leaves expanded, each pair in its own plane, and the pairs alternating, show that we have here to do with the stem and foliage of an aquatic plant of a marked and peculiar character. To this character no living plant seems to approach so nearly as Cabomba, and here the resemblance is so close that the probabilities become very strong that the reference to that genus will be confirmed hereafter by the discovery of the floating leaves and flowers.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota

Cabomba inermis (Newb.) Hollick.

Pl. XXII, fig. 2; XXIII, fig. 2.

Psilotum inerme, Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 38; Ills. Cret. and Tert. Pl. (1878), Pl. VII, fig. 2, under "aquatic rootlets of Equisetum"; VIII, fig. 3, under *Psilotum inerme*.

Associated with the last-described species are a large number of dichotomously forked, flattened leaves, which are imperfectly represented in the figure given. These have all the general character of the smaller ones, but are many times larger—5 to 6 inches in length—so large, indeed, that it seems impossible that they should have appertained to the same species. A distinct and significant name has therefore been given to them.[1] These leaves are flattened and smooth, and have precisely the aspect of the broader leaves of the living Cabomba. Groups of these springing from a common base were formerly likened to Psilotum, and described in the Later Extinct Floras as *P. inerme;* but the study of additional material has led to the conviction that the probabilities are very much stronger that we have here a representation of a species of Cabomba. The isolated position of Cabomba in our modern flora is an indication that it is a relic of the past, and it was to be expected that in the sediments of the ancient fresh-water lakes of the far West, where the leaves of palms are preserved, affording evidence of a warm climate like that of our Southern States, traces of the former existence of Cabomba should be found. With some of the groups of leaves of the plant now under consideration are imperfect traces of fructification which in their general character confirm the reference to Cabomba, and yet are not sufficiently well preserved to thoroughly establish the botanical affinities of these plants. It is to be hoped that attention being called to this peculiar group of fossils, they will be specially sought and found in the Fort Union beds in such condition as to establish beyond question their botanical affinities.

In fig. 2, Pl. XXII, a pair of leaves is represented which are intermediate in size between the two forms described, and these are erroneously shaded in such a way as to give the impression of rounded stems; in fact, these leaves are perfectly flat and correspond in form and structure to the

[1] Dr. Newberry's manuscript name for this species is *C. grandis*, but under the accepted rules of nomenclature the original published specific name *inerme* must stand.—A. H.

others, but the plant was evidently somewhat decayed and mutilated before fossilization.

Taking the series of figures now given and referred to Cabomba, they might be supposed to represent three species or different phases of one, but the very large number of the smallest form contained in the collection, and the close correspondence in size and form exhibited by them, seems clearly to justify the conclusion that they represent but a single species, while the larger form also generally exhibits the same characteristics. The intermediate size represented in fig. 2, Pl. XXII, has few representatives in the collection, and hardly affords material for the creation of a distinct species. It has been thought better, therefore, to refer this to the larger one, to which it is most nearly allied in size.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Brasenia (?) antiqua Newb.

Pl. LXVIII, fig. 7.

Brasenia antiqua Newb. Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 514 (not *B. antiqua* Daws., Trans. Roy. Soc. Canada, III, sec. 4, p. 15, 1885 [1886]).

"Stems long, flexuous, cylindrical (now flattened), smooth, many times branched toward summit, bearing pedunculate spheroidal capitula consisting of numerous club-shaped pods."

We have here the remains of an aquatic plant, having the general structure of Brasenia as regards stem and fruit, but the specimens are too imperfect to enable us to decide with confidence on its botanical relations. No leaves or flowers have yet been found, and the seeds are scarcely sufficient for its classification. Our common water shield, *Brasenia peltata*, is a very widely disseminated plant, as it is found on both sides of our continent and in Japan and the East Indies. This indicates that it has long been an inhabitant of the earth's surface, and whether the specimen before us can be accepted as evidence of its existence in North America during the Tertiary, the probabilities are strong that Brasenia was an inhabitant of the old lakes of the West and that its remains will be met with.

Formation and locality: Tertiary (Green River group). Green River, Wyoming

Order MAGNOLIACEÆ.

Magnolia alternans Heer?.

Pl. V, fig. 6.

Nouv. Mem. Soc. Helv. Sci. Nat., Vol. XXII (1866), p. 20, Pl. III, figs. 2–4; IV, figs. 1, 2.

Note.—So identified, provisionally, by Dr. Newberry, as indicated by memorandum on margin of plate. Locality probably Blackbird Hill, Nebraska.—A. H.

Magnolia elliptica Newb. n. sp.

Pl. XII, fig. 1.

Leaf 6 inches long by 3½ inches broad, elliptical in outline, rounded at the base, acute at the summit; midrib strong and straight; lateral nerves numerous, strong, nearly simple, arched upward, parallel, inosculating near margin (camptodrome).

Collected by Dr. F. V. Hayden.

Among described species, this approaches nearest to *M. Hilgardiana* Lesq. of the Tertiary of the Mississippi, but is shorter, broader, more rounded at the base, and more abruptly pointed at the summit.

There is some doubt in regard to the age of the strata from which this plant was derived, and it is possible that it is tertiary and is but a phase or variety of the species with which it has been compared.

Formation and locality: Tertiary (Eocene ?). Tongue River, Montana.

Magnolia obovata Newb.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 15.

"Leaves large, obovate, entire, thick and smooth; pointed and slightly decurrent on the petiole; nervation strong; midrib straight and extending to the summit; lateral nerves pinnate, set at somewhat unequal distances, straight and parallel below, forked and inosculating above, forming a festoon parallel with the margin; tertiary nerves forming an irregular network of polygonal and relatively large areoles."

Note.—As may be seen by comparing the descriptions, this species is manifestly identical with the one described by Dr. Newberry under the name *Nyssa vetusta* (see p. 125 of this monograph), and inasmuch as the latter name has priority

of place in the publication where they both originally appeared, the name *Magnolia obovata* becomes a *nomen nudum*. How this could have escaped Dr. Newberry's attention or the attention of subsequent workers and reviewers is strange.—A. H.

Magnolia rotundifolia Newb.

Pl. LIX, fig. 1.

Proc. U. S. Nat. Mus., Vol. V (March 31, 1883), p. 513.

"Leaves petioled, large (8 inches in length by 6 inches in width), round-ovate in outline, rounded or blunt-pointed above and slightly wedge-shaped below; margins entire; nervation open and delicate; four to six lateral branches given off from the midrib at remote and irregular distances, curving gently upward, and forming festoons near the margin."

Collected by Dr. F. V. Hayden.

In general form this fine species would seem to be somewhat like *M. regalis* Heer (Fl. Foss. Arct., Vol. IV, Abth. I, p. 81, Pl. XX; XXI, figs. 1, 2) and *M. Nordenskiöldia* Heer (*op. cit.*, p. 82, Pl. XXI, fig. 3; XXX, fig. 1), but with a much more slender and less crowded nervation than the first and a more rounded form than the second. A number of specimens in the collection show some diversity of form, and it is possible that the leaf figured is more rounded and less pointed than the average, but unless there should be very great departure from this standard there is little probability of this species being united with any other. The nervation is almost precisely that of the living *M. acuminata*, and there can not be any reasonable doubt that it is a representative of the same genus.

Formation and locality: Cretaceous (Laramie group). Fischers Peak, Colorado.

Liriodendron Meekii Heer.

Pl. VI, figs. 5, 6.

Proc. Phil. Acad. Nat. Sci. 1858, p. 265; Nouv. Mem. Soc. Helv. Sci. Nat., Vol. XXII (1866), p. 21, Pl. IV, figs. 3, 4; Ills. Cret. and Tert. Pl. (1878), Pl. VI, figs. 5, 6 [fig. 6 under *L. primævum*].

Note.—So identified by Dr. Newberry, as indicated by memoranda on margin of plate and on specimen label.—A. H.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska

Liriodendron primævum Newb.

Pl. VI, fig. 7.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 12; Ills. Cret. and Tert. Pl. (1878), Pl. VI, fig. 7. [Not named on plate.]

"Leaves three-lobed, upper lobe emarginate, all the lobes rounded; nervation delicate, principal nerve straight or slightly curved, terminating in the sinus of the superior lobe; secondary nerves gently arching upward, simple or forked near the extremities, a few more delicate ones alternating with the stronger."

Collected by Dr. F. V. Hayden.

This leaf is considerably larger than that of *L. Meekii* Heer, less deeply lobed, and the lobes more broadly rounded. In its general aspect this species approaches much nearer the living tulip tree and the Tertiary species of Europe (*L. Procaccinii* Ung.) than that described by Professor Heer from the collections of Dr. Hayden (*L. Meekii*). The leaves of the former species are, however, generally more deeply lobed and the lobes are acute, but I have collected leaves of *L. tulipifera* of small size with all the lobes rounded and in all respects remarkably like that under consideration. On the whole this is so like the leaf of our tulip tree that there can be little doubt that it represents a species of the same genus which grew on our continent at the commencement of the Cretaceous epoch. This is one of the most important facts deduced from the collections of Dr. Hayden, for the genus *Liriodendron* is now represented by but a single known species, which is confined to North America. During the Miocene Tertiary epoch, however, it formed part of the flora of Europe, as well preserved leaves of a species very closely allied to, if not identical with, the living one grew in Italy, Switzerland, and Iceland.

Thus this comes into the interesting category of Magnolia, Liquidambar, Sassafras, etc., genera which flourished both in Europe and America during the Miocene epoch, but which have long since ceased to exist on the European continent.

These specimens also teach us the still more interesting truth that Liriodendron, Sassafras, Magnolia, Quercus, Salix, Platanus, Populus, and many others of our living genera date back on this continent to a period long anterior to the dawn of the Tertiary age, and having survived all the

changes of the incalculable interval now form the most conspicuous elements in our existing forests.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Order BERBERIDACEÆ.

BERBERIS SIMPLEX Newb.

Pl. LVI, fig. 2.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 514.

"Leaves pinnate, with three or more pairs of leaflets; leaflets ovoid, rounded or emarginate at base, acute, with two to four large spiny teeth on each side."

Collected by Rev. Thomas Condon.

This, so far as known, is the first example of the occurrence of a Berberis in the fossil state in America, and of this we have only a single specimen, though that is unmistakable in its character. It is evidently allied to *B. aquifolium*, which grows so abundantly in the region where the fossil was found, but differs from it in the small number and large size of the teeth on the margins of the leaflets in the fossil. It is true that occasionally the smaller variety of *B. aquifolium* (*B. repens* Lind.) has leaflets very much like these, and I have before me as I write a specimen which I collected at Lake City, Colorado, in which some of the leaflets are almost precisely like these, differing from the fossil only in the less prolonged acute apex, and the narrower, somewhat wedge-shaped base. The surface of the fossil is quite smooth, showing almost nothing of the details of nervation; and this in a rock where the finer nerve markings are often most beautifully shown, as in the leaf represented on the same plate and which was obtained from the same beds. Hence we may conclude that in texture the leaf was thicker and its surface smoother than in *B. aquifolium*, in which the strong reticulated nervation is distinctly shown on both sides In some specimens of *B. Nepaulensis* from the Himalayas we find a closer resemblance to the fossil plant than is offered by any of our native species, viz, sessile and slightly cordate leaflets with a simpler nervation, showing on the under side only the midrib and a basal pair of branches; teeth three to five on each side, the point produced as in the fossil.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Order LAURACEÆ.

Sassafras cretaceum Newb.

Pl. VI, figs. 1–4; VII, figs. 1–3, VIII, figs. 1, 2.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 14; Ills. Cret. and Tert. Pl. (1878), Pl. VI, figs. 1–4.

S. Mudgii Lesq. Am. Journ. Sci., Vol. XLVI (July, 1868), p. 99; *S. Mudgei* Lesq. Cret. Fl. (1874), p. 78, Pl. XIV, figs. 3, 4; XXX, fig. 7.

S. subintegrifolius Lesq. Am. Journ. Sci., Vol. XLVI (July, 1868), p. 99; *S.* (?) *subintegrifolium* Lesq. Cret. Fl. (1874), p. 82, Pl. III, fig. 3 (misquoted fig. 5.)

S. Harkeriana Lesq. Hayden's Ann. Rept., 1872 [1873], p. 425; *S. Harkerianum* Lesq. Cret. Fl. (1874), p. 81, Pl. XIII, figs. 3, 4; XXVII, fig. 2.

S. obtusus Lesq. Hayden's Ann. Rept., 1871 [1872], p. 303; *S. obtusum* Lesq. Cret. Fl. (1874), p. 81, Pl. XIII, figs. 2–4.

Populites salisburiæfolia Lesq.? Am. Journ. Sci., Vol. XLVI (July, 1868), p. 94.

S. (*Araliopsis*) *cretaceum* Newb. var. *dentatum* Lesq. Hayden's Ann. Rept., 1874 [1876], p. 344; *S. cretaceum* Newb. Lesq. in Cret. Fl. (1874), p. 80, Pl. XI, figs. 1, 2.

S. acutilobum Lesq. Cret. Fl. (1874), p. 79, Pl. XIV, figs. 1, 2.

S. (*Araliopsis*) *cretaceum* Newb. var. *obtusum* Lesq. Cret. Fl. (1874), p. 80, Pl. XII, fig. 3; XIII, fig. 1.

"Leaves petiolate, decurrent at base, very smooth above, strongly nerved below; three-lobed; lobes entire and acute. The nervation is all strongly defined; the central nerve straight or nearly so; the lateral primary nerve springing from it at an angle of 30 degrees; secondary nerves regularly arched till they approach the margin of the lobes, when they are abruptly curved and run together. From these the tertiary nerves are given off at a right angle, and from these the quaternary nerves spring at a similar angle, together forming a network of which the areoles are subquadrate."

Collected by Dr. F. V. Hayden.

It is perhaps not certain that the relationship between this beautiful fossil and the living Sassafras is as intimate as I have suggested, for Dr. Hayden obtained no fruits with the leaves, though from the abundance of the latter it is to be hoped that they may yet be found in the same locality. Until the fructification shall be procured, the suggestion that a species of our modern genus Sassafras flourished as far back as the epoch of the

deposition of the Middle Cretaceous strata, may be accepted with a certain degree of mental reservation. It is true, however, that there is a most marked correspondence, both in external form and nervation, between the living and the fossil plants, the differences being no greater than we might expect to find between species of the same genus. The nervation of the fossils is stronger and more regular, and the whole aspect of the leaf rather neater and more symmetrical.

With the material already before us we may at least infer that there was living in the American forests of the Cretaceous period a Lauraceous tree, bearing trilobate leaves, having the general aspect and nervation of those of our Sassafras.

The large collections made from the Dakota group at Fort Harker and elsewhere since the above note was written have included a great number of trilobate leaves, which are not separable by any constant and well-marked character from those which formed the basis of the above description, viz, figs. 1 to 4, Pl. VI. On these, however, Lesquereux has established a number of species of Sassafras, namely, *S. acutilobum* (the form figured on Pl. VII, fig. 1), *S. Harkerianum* (shown in our fig. 2, Pl. VIII), *S. Mudgei*, (Pl. VII, fig. 2) *S. obtusum* (Pl. VIII, fig. 1), *S. subintegrifolius* (Pl. VII, fig. 3), etc.

A very large number of beautifully preserved specimens collected by Mr. Sternberg at Fort Harker, and which have been submitted to me for examination, show so many connecting links between these different forms that I am quite unable to separate them into distinct species.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska; Fort Harker and Smoky Hill Fork, Kansas.

Sassafras cretaceum recurvatum (Lesq.) Newb.

Pl. IX, fig. 2.

Sassafras recurvatus Lesq. Hayden's Ann. Rept., 1872 [1873] p. 424.
Platanus recurvata Lesq. Cret. Fl. (1874), p. 71, Pl. X, figs. 3–5.

Note.—Dr. Newberry considered this leaf to be a variety of his *S. cretaceum*, as indicated by a memorandum on the margin of the plate.—A. H.

Formation and locality: Cretaceous (Dakota group). Fort Harker, Kansas

Cinnamomum Heerii Lesq.

Pl. XVII, figs. 1–3.

Am. Journ. Sci., Vol. XXVII (1859), p. 361; Trans. Am. Phil. Soc., Vol. XIII (1869), p. 431, Pl. XXIII, fig. 12; Cret. Fl. (1874), p. 84, Pl. XXVIII, fig. 11.

Guided only by the brief description given by Lesquereux, I can not be positive that the species of Cinnamomum before us is identical with that procured by Dr. Evans from Vancouvers Island. In Lesquereux's specimens the summit of the leaf was wanting, but he conjectures that the lateral nerves extended to the point. Among my specimens are several in which the upper extremity of the leaf is preserved.

From these it appears that the lateral nerves terminate in the margin before reaching the point. This would separate it from *C. Buchi*, and would bring it nearer to *C. Scheuchzeri* or *C. lanceolatum*. My specimens, however, indicate a larger and thicker leaf than that of either of these species.

It would be a matter of no little interest to determine the relations of the specimens of Cinnamomum contained in the Northwest Boundary Collection with those brought from Vancouver Island and Bellingham Bay by Dr. Evans, as that would probably permit us to decide whether the plant beds of Orcas Island should be grouped with those of the mainland or with those of Nanaimo.

Formation and locality: Cretaceous (Puget Sound group). Orcas Island, Washington.

Order HAMAMELIDACEÆ.

Liquidambar Europæum Al. Br.

Pl. XLVII, figs. 1–3.

In Buckl. Geol. and Mineral., p. 513 (1837).

In the collection of fossil plants made by Rev. Thomas Condon at Bridge Creek, Oregon, occur a number of fragments of the leaves of a Liquidambar which I am unable to distinguish from some of the forms of the species known as *L. Europæum* Al. Br. The leaves are large, five to seven lobed, the lobes ovoid, long-pointed, and finely serrate. A fragment of a leaf apparently precisely like this is figured by Heer in his Flora of Alaska (Fl. Foss. Arct., Vol. II, Abth. II, p. 25, Pl. II, fig. 7), and is referred by him to *L. Europæum*. The fruit associated with the leaves at Bridge Creek, as represented in fig. 3, is smaller than that of the living

Liquidambar of the Atlantic coast of North America, and the capsules are smaller. The leaves of Liquidambar are found generally distributed through the Middle Tertiary of Europe and have been described from many localities. They exhibit a great diversity in size and form, as is true of the living species above referred to, and it is the opinion of Heer and Schimper that this is the descendant of the fossil one.

Lesquereux has described a species of Liquidambar from the Pliocene deposits of Chalk Bluff, California, which he regards as distinct from *L. Europæum*. The largest specimen which he figures has almost exactly the form of those before us, but he says that they are usually small, and three-lobed. Probably this also is to be regarded as only a variety of *L. Europæum*, and all forms as hardly distinguishable from the living *L. styraciflua*. This species is quite variable. In northern Mexico the tree and leaves are small and the latter are all three-lobed. In Louisiana the Sweet Gum often forms the greater part of the forest growth; the trunk attains the height of 60 to 80 feet, with a diameter of 2 to 3 feet. The tree grows along the coast as far north as Massachusetts, and has leaves 6 to 7 inches in diameter. They are generally five-lobed, but I have found on the same tree leaves that were three-, five-, and seven-lobed.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Liquidambar obtusilobatus (Heer) Hollick.

Pl. V, fig. 4; XII, fig. 4.

Phyllites obtusilobatus Heer. Proc. Acad. Nat. Sci. Phila. (1858), p. 266.
Acerites pristinus Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 15.
Liquidambar integrifolius Lesq. Am. Journ. Sci., Vol. XLVI (July, 1868), p. 93; Cret. Fl. (1874), p. 56, Pl. II, figs. 1–3; XXIV, fig. 2; XXIX, fig. 8; Ills. Cret. and Tert. Pl. (1878), Pl. V, fig. 4, under *Acerites pristinus*.

This is the leaf first described by Professor Heer, from an outline sketch, in the Proceedings of the Academy of Natural Sciences, Philadelphia, 1858, page 266, under the name of *Phyllites obtusilobatus*. When, in 1868, the Later Extinct Floras of North America was published, an imperfect specimen was described by the writer as *Acerites pristinus*. Subsequently several much better specimens were obtained by Lesquereux which led him to refer it to the genus Liquidambar. His description is given in American Journal of Science, Vol. XLVI (July, 1868),

page 93, and in his Cretaceous Flora, page 56, where it is illustrated by numerous figures. Nearly all of these represent somewhat deeply five-lobed leaves, of which the lobes are pointed and sometimes acute. The figure given on Pl. XII of this monograph shows that the lobes may sometimes become broadly rounded.

Since this note was written I have found in the Amboy Clays of New Jersey—a formation about on a level geologically with the Dakota group—leaves which I can not distinguish from those figured by Mr. Lesquereux.[1] All these five-lobed entire margined leaves contrast somewhat strongly with those of the living species, and I am disposed to doubt the propriety of referring them to the same genus. The leaves of *L. styraciflua* are quite variable in size and form, but always have pointed lobes and serrated margins. In Northern Mexico all the "sweet gum" trees have three-lobed leaves, rarely more than 3 inches in diameter, while in New Jersey the leaves are from five to seven lobed and generally from 5 to 6 inches in diameter.

In the Puget Sound group a small three-lobed leaf occurs which could hardly be distinguished from these of the Mexican variety of the common species. These, like those of *L. Europæus*, as figured by Unger and Heer, can not be doubted to be Liquidambar, but the leaves now under consideration seem to me more likely to belong to the group of three- to five-lobed Aralias that are so common in the Dakota and Amboy groups.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska, and Fort Harker, Kansas.

Order PLATANACEÆ.

Platanus aspera Newb.

Pl. XLII, figs. 1–3; XLIV, fig. 5; LIX, fig. 3.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 509.

"Leaves attaining a diameter of 1 foot or more; petioled; rounded at the base, more or less three-lobed, sometimes nearly ovoid; nervation strong, about nine branches on each side of the midrib; margins deeply, and often compoundly toothed."

Collected by Rev. Thomas Condon.

[1] Dr. Newberry probably has reference to *Aralia rotundiloba* Newb. Flora of the Amboy Clays, p. 118, Pl. XXVIII, fig. 5; XXXVI, fig. 9 (Mon. U. S. Geol. Surv., Vol. XXVI).—A. H.

We have here in the specimens which are figured and others similar, representatives of a fine species of Platanus which is apparently distinct from any hitherto described. In general form it most resembles *P. Haydenii* Newb., and may prove to be only a variety of this species; but the leaves of *P. Haydenii* obtained in Wyoming have only an undulate or bluntly toothed margin; it is well known, however, that this is a character which is exceedingly variable, and specific distinctions can hardly be based upon it. However, the marginal teeth shown in figs. 1 and 2, the base and summit of the leaf, are so peculiar in their size and their compound character that without connecting links we should not be justified in uniting these leaves with any others. In fig. 3 of the plate cited it will be noticed that the dentation at the base of the middle lobe is smaller and more like that in *P. Haydenii*, but the margins in this specimen are so incomplete that they afford information of but little value. Its chief importance is its demonstration of the large size and distinctly trilobate outline of some of the leaves of this tree.

The leaf figured in Pl. XLIV, fig. 5, presents a marked difference of form from those represented on Pl. XLII, but the character of the margins is the same, and it seems probable that this is only the ovoid form which the young and some of the mature leaves are prone to assume. Until further light shall be thrown on the subject it is safest to consider all the leaves mentioned in this note as belonging to the same species.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Platanus Haydenii Newb.

Pl. XXXVI; XXXVIII; LVI, fig. 3.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 70; Ills. Cret. and Tert. Pl. (1878), Pl. XIX; XXI.

"Leaves large, long-petioled, when mature three, perhaps rarely five lobed; lobes nearly equal, long-pointed, acute; on either side of the middle lobe five to eight obtuse teeth; margins of the lateral lobes sinuately toothed to near the base; younger leaves ovate, acuminate, coarsely toothed throughout, except near the base, which is slightly decurrent; nervation strong, radiate from the base, primary nerves three, which are nearly straight, and terminate in the three lobes of the border. From the midrib

spring seven or eight pairs of lateral nerves above the basilar pair; these diverge at an angle of about 35 degrees, are slightly flexed at the base, straight or nearly so above, where they are somewhat truncated, their branches terminating in the marginal teeth. The basilar nerves diverge from the midrib at an angle of about 35 degrees and run nearly straight to the extremities of the lateral lobes. They each give off on the lower side seven or eight branches, of which the second or third is strongest. These are more or less curved and branched, the branches terminating in the teeth of the margin. Fruit two to three lines long, prismatic, clavate."

Collected by Dr. F. V. Hayden.

This fine species, which is well represented in the collection, is closely related to *Platanus aceroides*, so common in the Miocene strata of Europe. There are, however, noticeable differences, which seem to me to have a specific value. The leaves of *P aceroides*, though exhibiting a great variety of form, are, I believe, always acutely toothed, while in the specimens before us the teeth are never acute, except those which in the young leaves represent the lateral lobes of the mature form. In *P. aceroides* also, according to Heer (Fl. Tert. Helv., Vol. II, p. 71, Pl. LXXXVII and LXXXVIII, figs. 5–15), the nervation is more sparse, the angle of divergence of all the nerves greater, the number of lateral branches of the midrib less, and the number of marginal teeth considerably greater. Professor Heer says (*loc. cit.*) that in *P. aceroides* the middle lobe of the leaf has two to three dentations on either side, while in *P. Haydenii* the mature leaf has eight to ten teeth on each side of the middle lobe. The difference before specified in the form of the marginal teeth is very marked and strikes the eye at a glance. In *P. aceroides* they are few, long, and acute, sometimes even uncinate, while in *P. Haydenii* they are more numerous, less prominent, and always obtuse, sometimes merely giving a wavy outline to the margin of the leaf.

Detached seeds are all that we have of the fruit, and these, though plainly derived from a Platanus, in their condition of fossilization afford no good characters with which to compare this species with the two now living on this continent, or with the living and fossil species of the Old World.

P. aceroides, according to Heer, had fruit in racemes like the Mexican plane tree, while the fruit of *P. occidentalis* is single. In general aspect the species now before us is more like the eastern than the western of our

American sycamores, to the former of which it has considerable likeness and may very well have been its progenitor.

The fine leaf figured on Pl. XXXVIII, from La Bontes Creek, is probably a young or abnormal state of this species, as it occurs with the ordinary trilobate form.

Formation and locality: Tertiary (Eocene ?). Banks of the Yellowstone River, Montana.

Platanus latiloba Newb.

Pl. I, fig. 4.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 23; Ills. Cret. and Tert. Pl. (1878), Pl. II, fig. 4.
Platanus obtusiloba Lesq. Am. Journ. Sci., Vol. XLVI (July, 1868), p. 97.
Sassafras (*Araliopsis*) *mirabile* Lesq. ? Cret. Fl. (1874), p. 80, Pl. XII, fig. 1.

"Leaves petiolate, three-lobed, decurrent at the base, lobes broad, obtuse, or abruptly acuminate; principal nerves three, secondary nerves issuing from these at an acute angle, tertiary nerves leaving the secondary at a right angle. forming a network over the surface of the leaf, of which the areolæ are subquadrate."

Collected by Dr. F. V. Hayden.

Judging from the imperfect specimens which we have of this species, it is quite distinct from any described. Having the general form and nervation of the leaves of *P. occidentalis*, the margins are much less deeply sinuate, the lobes less acuminate, and the entire outline of the leaf more simple. The same is true of its relations with *P. orientalis* of the Old World. The fossil species, of which several have been described by Unger and Goeppert, are quite distinct from this. The species described by Unger (*P. Sirii* and *P. grandifolia*) are much more deeply lobed, while that figured by Heer, Goeppert, and Ettingshausen (*P. aceroides*) is less deeply lobed, but more strongly toothed. All fossil species heretofore known are from the Tertiary strata, this being the first instance where the genus has been found in rocks of the Cretaceous epoch.

A large number of nearly complete specimens of the leaf described above have recently been obtained from the Dakota sandstones near Fort Harker, Kansas. Some of these have come into the possession of Lesquereux, who has included them in the genus Sassafras, and has figured

and described some of them in his Cretaceous Flora under the name of *Sassafras* (*Araliopsis*) *mirabile*.

Count Saporta has raised the question whether any of the trilobate leaves referred by Lesquereux and myself to Sassafras really belong to this genus, and has suggested that their affinities are more likely to be with Aralia. This question can only be definitely settled by the discovery of the fruits of the tree which bore these leaves; these will undoubtedly be found when they are carefully looked for by collectors. Waiting such time, however, we may say that some of the many trilobate leaves found in the Dakota group by their form and nervation are much more like the leaves of Sasafras than those of any other living genus. In these the form is elegantly trilobate, the margins entire, the lobes rounded or obtusely pointed; the nervation is camptodrome. Possibly these leaves will be found to shade into those now under consideration, but judging from the material now before us the difference is considerable. For example, these leaves are larger, have a waved and sometimes even denticulate margin above, while the nerves are stronger and straighter, terminating in the denticles of the border. In all these respects they are more like the leaves of Platanus than those of Sassafras, and they are therefore for the present retained in the genus to which they were referred in the first published description.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Platanus nobilis Newb.

Pl. XXXIV; XXXVII, fig. 1; L, fig. 1.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 67; Ills. Cret. and Tert. Pl. (1878), Pl. XVII; XX, fig. 1, under *P. Haydenii*.

"Leaves large, 1½ feet in length and breadth, petioled, three-lobed or subfive-lobed, lobes acute, margins of lobes and base entire, or near the summits of the lobes delicately sinuate-toothed; nervation strongly marked, generally parallel; medial nerve straight, two basilar nerves of nearly equal length and strength diverge from it at an angle of 30 to 35 degrees, are straight throughout, and terminate in the apices of the principal lateral lobes. Above the basilar nerves about 16 pairs of lateral nerves are given off from the midrib at about the same angle; these are nearly straight and parallel, terminating in the teeth of the margin. From

each of the basilar nerves diverge about the same number of pairs of branches as from the midrib, and these are also nearly straight and parallel, and terminate directly in the margin. Of these the second or third exterior one on each side is often much the stronger of the series, and is then prolonged into a small but distinct lateral, triangular, acute lobe, giving the leaf a somewhat pentagonal form. From this basilar branch of the lateral nerves, twelve or more short, generally simple, branchlets spring on the lower side, and four to five on the upper side near the summit, all of which terminate in the margins. The tertiary nerves connect the adjacent secondary nerves nearly at right angles; sometimes they are straight and parallel, but oftener more or less broken and branching where they meet, near the middle of the interspaces. Where the systems of nervation of the lateral and middle lobes come in contact, the tertiary nerves are stronger and form a somewhat irregular network, of which the areolæ are large and subquadrate."

Collected by Dr. F. V. Hayden.

In general aspect these magnificent leaves are considerably unlike those of any known species of Platanus, and I have felt some hesitation in referring them to that genus. The texture was evidently thicker and the surfaces smoother than in the leaves of most Sycamores, and, on the whole, they recall the leaves of Cecropia or some other of the broad, leathery, polished leaves borne by the trees of the tropics. On close examination, however, they are found to present the radical structure of the leaves of Platanus, and, aside from their association with so many genera plainly belonging to the flora of the temperate zone, their form and nervation seem to me to afford at least presumptive evidence that they were borne by a tree of that genus. They will, perhaps, suggest to the fossil botanist the leaves described by Unger under the names of *Platanus Hercules*, *P. Jatrophæfolia*, etc. (Chlor. Prot., p. 137, Pl. XLV, figs. 6, 7, etc.), and which he subsequently removed from that genus. But those palmate, many-lobed leaves were very unlike these now before us, and resemble much more the leaves of Jatropha or Sterculia than those of Platanus.

The crowded, somewhat heavy and regular nervation of these leaves, their thick texture and polished surface, must have given the tree on which they grew an aspect quite different from that of *P. occidentalis;* but *P. orientalis*, and sometimes *P. racemosa*, have thick and polished leaves,

and the deviation from the common form is not so great in these fossils as in the living species I have named, or the fossil species named by Unger, *P grandifolia* and *P. Sirii* (Chlor. Prot., p. 136, Pl. XLV, figs. 1–5, and Foss. Fl. Sotzka, p. 36 [166], Pl. XV [XXXVI]), fig. 1.

In size these leaves exceed those of any known species of Sycamore, and if we are correct in referring them to Platanus, they may be considered the only relics we have of by far the noblest species of the genus. Some of the leaves are a foot and a half in length and of about equal breadth, and yet they do not so far exceed the ordinary size of the leaves of the Sycamores as do the leaves of *Acer macrophyllum* those of other species of maple.

Since the above notes were written, Lesquereux has described (Tert. Fl., p. 237, Pl. XXXIX, figs. 2–4) some trilobate, sometimes five-lobed leaves, which he compares with *Platanus nobilis*, and is inclined to regard them as identical; but it will only be necessary to refer to the figures now given, especially that on Plate L, to show that the differences are such as to distinctly separate them. In *Aralia notata* Lesq., the general plan is not unlike that of the leaves in question (which is true also of most trilobate leaves), but here the resemblance ceases, for in *A. notata* the margins are entire and the lateral nerves connect in festoons along the margin (camptodrome), whereas in *P. nobilis* the lateral branches terminate in the teeth with which the margins of the lobes are set (craspedodrome).

In the Report of Progress of the Geological and Natural History Survey of Canada for 1879–80, Appendix N, Prof. J. W. Dawson gives notes on a number of species of plants collected on the Souris River, and among others he mentions *Platanus nobilis*, of which good specimens were procured by Dr. Selwyn and Dr. G. M. Dawson, and he confirms, by observations on these specimens, my reference to the genus Platanus. He also mentions a feature which does not appear in any of the specimens I have seen, namely, two short basal lobes extending backward on the petiole. This is not, however, unprecedented in the leaves of Platanus, as I have seen something of the kind in the large leaves borne by young and vigorous plants of *P. occidentalis*. The figure given on Pl. L is of the natural size, and attests the magnitude claimed for some of the leaves of this magnificent tree. When it is realized that the main nerves of the middle and lateral lobes must unite at a point some inches below the part

represented at the bottom of the figure, and that the central lobe was at least 6 inches and the lateral lobes 3 or 4 inches larger than represented, it will be seen that the leaf could not have been much less than a foot and a half in length and breadth. These dimensions are rivaled by no living species of Platanus, but I have fragments of the leaves of *P. Raynoldsii* which could have been little less in size.

The leaf figured on Pl. XXXVII, fig. 1, is an immature form of this species. This is established by its occurrence with the larger and more deeply lobed leaves, with which it is connected by intermediate forms.

Formation and locality: Tertiary (Eocene?). Near Fort Clark, Dakota.

Platanus Raynoldsii Newb.

Pl. XXXV.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 69; Ills. Cret. and Tert. Pl. (1878), Pl. XVIII.

"Leaves of large size, sub-orbicular or rudely triangular in outline, more or less rounded below, three-pointed above, often decurrent on to the petiole, margins at base entire, on the sides and above, coarsely and obtusely double-serrate, the lobes of the upper margin short and broad, less produced than in most other species; nervation strong but open, having the general character of *P. occidentalis* and of the fossil species *P. aceroides*."

Collected by Dr. F. V. Hayden.

The younger leaves are rounded in outline and decurrent on the petiole. Those more fully developed (which are sometimes 15 inches in length and breadth), more triangular in form, not always decurrent, and having lobes more produced, offer considerable resemblance to those of *P. aceroides*, an extinct species from the Miocene of Europe, the nervation being similar in kind and not greatly different in degree. The leaf is, however, always less angular than in *P. aceroides* and *P. Haydenii*, and the character of the marginal serration is essentially different from that of any known species. In *P. aceroides* the margins are set with long, acute, curved, simple teeth, as in the living *P. occidentalis;* in *P. Haydenii* the margins are for the most part only sinuate; and in *P. nobilis* the middle lobes only are toothed, and those but slightly; while in the species before us, with the exception of the basal margin, the whole outline is marked by a broad, strong, double dentation.

The figure given on Pl. XXXV is that of a complete leaf about half the size, linear, of the largest contained in the collection.

In texture the leaf was apparently similar to that of *P. occidentalis*, rather thin and more or less roughened.

Formation and locality: Tertiary (Eocene?). Banks of Yellowstone River, Montana.

Order ROSACEÆ.

Pyrus cretacea Newb.

Pl. I, fig. 7.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 12; Ills. Cret. and Tert. Pl. (1878), Pl. II, fig. 7.

"Leaves petioled, small, roundish-oval or elliptical, often slightly emarginate, entire or finely serrate; medial nerve strong below, rapidly diminishing toward the summit; lateral nerves four or five pairs with intermediate smaller ones, diverging from the midrib at unequal angles, curved toward the summits, where they anastomose in a series of arches parallel with the margin; tertiary nerves forming a network of which the areolæ are somewhat elongated."

Collected by Dr. F. V. Hayden.

There are a number of leaves in the collection, of which the characters, as far as they are discernible, agree more closely with those of the species of Pyrus than with any other with which I have compared them. All the traces of their original structure which remain, however, are quite insufficient to permit their generic limitation to be determined with any degree of certainty. The leaves of many of the allied genera of the Rosaceæ have so much in common that even with the leaves of the living plants it would be difficult, if not impossible, to separate them. The fossils before us are, however, very characteristic of the formation which contains them, and for that reason require notice, and, as far as practicable, description.

There are several other leaves in the collection which seem to me to have belonged to Rosaceous trees, and there is perhaps no a priori improbability that Pyrus began its existence on this continent with its congeners and companions in our forests of the present day.

Formation and locality: Cretaceous (Dakota group). Smoky Hill, Kansas.

Amelanchier similis Newb.

Pl. XL, fig. 6.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 48; Ills. Cret. and Tert. Pl. (1878), Pl. XXV, fig. 6.

"Leaves petioled, ovate, obtuse or acuminate, rounded or slightly cordate at the base; margin coarsely toothed, except near the petiole, where it is entire; nervation pinnate, delicate; medial nerve straight, six to seven pairs of lateral nerves diverging from the midrib at an angle of about 40 degrees, slightly curved upward, especially near the summit, the upper ones nearly simple, but giving off a perceptible branch near the summit on the lower side, which runs into the next tooth below. The lower pair spring from the extreme base of the leaf, are strong and simple, and strike the margin where the dentation commences. The second pair of lateral nerves each send off two or three slender nerves from near the summit to the teeth of the adjacent margin; tertiary nerves very fine, leaving the secondaries at right angles, and forming a fine network of which the areolæ are nearly quadrate."

Collected by Dr. F. V. Hayden.

The number of specimens of this species in the collection is small and all but one are imperfect. This one is the impression of a thin, delicate leaf, of which all the details of nervation are preserved as perfectly as they could have appeared in the living plant. The other specimens indicate that the leaves were usually pointed, often acute.

From the nervation and character of dentation of these leaves, I think we may at least say that the plant which bore them was Rosaceous, and among the Rosaceous genera with which I have compared them they approach most nearly to *Amelanchier*, some of the leaves of *A. Canadensis* being entirely undistinguishable from them in form or nervation.

A. Canadensis now grows over all the temperate parts of the continent and would seem from its wide range to be an old resident of the continent and as likely to be represented in the Tertiary as any other of our plants.

Formation and locality: Tertiary (Eocene?). Banks of Yellowstone River, Montana.

Cratægus flavescens Newb.

Pl. XLVIII, fig. 1.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 507.

"Leaves small, about 1 inch in length and breadth; lobed; lobes rounded and bearing a few teeth or crenulations; the summit of the leaf trilobed, with two lateral lobes below on either side."

Several small, lobed leaves are contained in the collection made by Rev. Thomas Condon, which bear such resemblance to those of some species of Cratægus that we seem to be justified in referring them to this genus. Of these the one figured is the most complete in outline; this in its general proportions and markings approaches closely to the leaves of *C. flava* Ait., but in that species the leaves are usually somewhat larger and the lobes are set with several acute teeth.

Eighteen fossil species of Cratægus have been described, and of these three from the Tertiary deposits of North America, namely, *C. antiqua* Heer (Fl. Foss. Arct., Vol. I, p. 125, Pl. L, figs. 1, 2), *C. Warthana* Heer, and *C. æquidentata* Lesq. (Tert. Fl., p. 297, Pl. LVIII, figs. 4, 4a); but these are much larger and have rhomboidal and undivided leaves; indeed, it is not certain that they all belong to the genus Cratægus.

Of foreign species there is none with which this is likely to be confounded. *C. dyssenterica* Mass. (Fl. Foss. Senigall, p. 414, Pl. XIX, fig. 1), is similarly lobed, but the leaves are larger and much more deeply cut.

The resemblance of the leaves before us to those of the living *C. flava* is so close that it is quite possible that the present is the derivative from the ancient species, a possibility suggested in the specific name chosen.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Prunus variabilis Newb.

Pl. LII, figs. 3 and 4 (in part), 5.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 509.

"Leaves short-petioled, very variable in form; lanceolate or broadly lance-ovate, 2 to 3 inches long by 1 to 2 inches wide; acuminate at the summit, wedge-shaped at base; margins thickly set with minute, acute, appressed teeth."

Numerous leaves, which evidently belong to the genus Prunus, occur

in the collections from Alaska made by Captain Howard, and sometimes several on the same slab that exhibit no differences except the marked variation in form shown in the figures and alluded to in the name given. Compared with the living species, these leaves have much the aspect of some of the forms of *P. Virginiana*, the marginal serration being very much the same, though the leaves of the living plant are usually obovate.

A species of Prunus is described by Professor Heer from the Tertiary strata of Greenland under the name of *P. Scottii* (Fl. Foss. Arct., Vol. I, p. 126, Pl. VIII, fig. 7), but the only leaves he describes and figures are much larger and longer and more coarsely toothed than these.

Numerous species of Prunus have been described from the Tertiary of the Old World, but so far as we can judge there are none that have the somewhat peculiar lanceolate leaf, broader in the middle than elsewhere and narrowed at both ends, terminating in a long point, like the one under consideration. It has been thought necessary, therefore, to distinguish this by a special specific name.

Formation and locality: Tertiary (Miocene). Cook Inlet, Alaska.

Order LEGUMINOSÆ.

Cassia sp.? Newb.

Pl. XLVI, fig. 10.

Note.—The only information which I have been able to obtain in regard to this figure is the manuscript note, "Cassia fruit," by Dr. Newberry, on the margin of the plate, and the locality given on the specimen label.—A. H.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Leguminosites Marcouanus Heer.

Pl. V, fig. 3.

Proc. Acad. Nat. Sci. Phila. (1858), p. 265; Ills. Cret. and Tert. Pl. (1878), Pl. V, fig. 3, under *Phyllites obcordatus*.

The original tracing of this leaf, on which Professor Heer has written the name given it, enables me to identify it with certainty and to correct an error which has been committed in reference to it, namely, that

its name has been given to another larger, broader, obovate leaf found with it, and described by Professor Heer with the name of *Phyllites obcordatus*.

The general form of these leaves is not unlike, but the one now under consideration is narrower, slightly unequal at the base, and has a remarkably sparse nervation, as will be seen by referring to the figures.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Order ANACARDIACEÆ

Rhus (?) nervosa Newb.

Pl. XXXIII, figs. 5, 6.

Rhus nervosa Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 53; Ills. Cret. and Tert. Pl. (1878), Pl. XVI, figs. 5, 6.

"Leaves pinnate, leaflets oblong or linear in outline, rounded or cordate at the base, pointed above; margins coarsely and acutely serrate; nervation pinnate, strong; lateral nerves numerous, leaving the midrib at an acute angle, simple or somewhat branched, parallel, gently arched upward, and terminating in the teeth of the border."

Collected by Dr. F. V. Hayden.

The specimens of this plant scarcely afford material for satisfactory classification. They bear a strong resemblance to the pinnate leaflets of some of our shrubby species of Rhus, especially of *R. copallina* and *R. typhina*. The nervation and marginal serration are essentially the same, and the texture of the leaf would appear to have been similar, but the nerves are stronger and the dentation coarser than in most specimens of these species with which I have compared it. With the trifoliate and oak-leaved species it has little in common, and will not be likely to be confounded with any of the fossil species which have been described.

The general form of the leaf is not unlike *R. Meriani* Heer (Fl. Tert. Helv., Vol. III, Pl. CXXVI, figs. 5–11), but the margins of the leaves of that species are not as deeply toothed.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Order ACERACEÆ.

ACER sp.? Newb.

Pl. XLVI, fig. 8.

NOTE.—The only information which I have been able to obtain in regard to this figure is the manuscript note, "Acer fruit," by Dr. Newberry, on the margin of the plate, and the locality as given on the specimen label.—A. H.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

NEGUNDO TRILOBA Newb.

Pl. XXXI, fig. 5.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 57; Ills. Cret. and Tert. Pl. (1878), Pl. XXIII, fig. 5.

"Leaves thin and delicate, but distinctly nerved, pinnate in one or more pairs, leaflets lanceolate or lance-ovate, long-pointed, rounded or slightly cordate at base, short-petioled; margins coarsely, remotely, and irregularly toothed; terminal leaflet trilobate, the margins toothed or serrated; nervation of lateral leaflets pinnate, nine or ten pairs of lateral nerves diverging from the midrib at an angle of about 50 degrees, arching upward, more or less branched toward the summit. Of these the basal pair are shortest and simple, following the course of the adjacent margin; the second pair are strongest, and throw off each three or four curved branches on the lower side."

Collected by Dr. F. V. Hayden.

The general aspect, including texture, form, dentation, and nervation of the lateral leaflets is strikingly like that of the corresponding parts of the leaf of the living *Negundo aceroides.* The genus Negundo is represented among living plants by but a single species, and this is so like Acer in all but its leaves that Professor Gray intimates that it should hardly be considered distinct from that genus. A fossil species has been discovered in the Tertiaries of Europe, *N. Europæum* Heer (Fl. Tert. Helv., Vol. III, p. 60, Pl. CXVIII, figs. 20–22), but it would seem to have been a smaller species than the living one, and had obovate wedge-based leaves quite different from those before us.

If, in the light of more and better material, it should prove that a species of Negundo lived on the American continent during the Tertiary

age, it would be a fact of no little interest, and would strengthen the claims of *Negundo aceroides* to a distinct generic place in the botanical series. In that case, however, its trilobate terminal leaflet would still further indicate its acerine affinities.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Order SAPINDACEÆ.

Sapindus affinis Newb.

Pl. XXX, fig. 1; XL, fig. 2.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 51; Ills. Cret. and Tert. Pl. (1878), Pl. XXIV, fig. 1; XXV, fig. 2.

"Leaves pinnate in many pairs of leaflets, with a single lanceolate terminal one; leaflets smooth, thick, lanceolate, long-pointed, acute, sessile or short-petioled, unsymmetrical, rounded or wedge-shaped at base; nerves fine and obscure, ten or more branches diverging from the midrib on either side at somewhat unequal distances, and of unequal size. These arch upward, giving off several lateral branches at right angles, or nearly so, and die out near the margins, or are carried around in a curve parallel with it, and thus connect."

Collected by Dr. F. V. Hayden.

These leaves are most strikingly like those of Sapindus, and taken by themselves would afford perhaps sufficient ground for uniting them with that genus. They are also very like a series of leaves found in the Tertiaries of Europe, figured by Professor Heer, in Fl. Tert. Helv., Vol. III, p. 61, Pls. CXIX, CXX, CXXI; under the names of *Sapindus falcifolius*, *S. densifolius*, and *S. dubius*. The nervation is also the same; so there can hardly be a doubt that our plant and those of Professor Heer are generically identical, and, if the proofs before him of the identity of his fossils with the living genus Sapindus are sufficient, we must conclude that the specimens before us are also the representatives of that genus. In our specimens, however, the leaves are constantly shorter and broader than in the species I have mentioned, and are often rounded at the base, so that I have been compelled to regard them as specifically distinct.

Formation and locality: Tertiary (Eocene?). Mouth of Yellowstone River, Montana.

Sapindus (?) membranaceus Newb.

Pl. XXX, figs. 2, 3.

Sapindus membranaceus Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 52; Ills. Cret. and Tert. Pl. (1878), Pl. XXIV, figs. 2, 3.

"Leaves pinnate in many pairs of leaflets, and terminating in a large ovate, often unsymmetrical one; lateral leaflets lanceolate, acute, wedge-shaped at base, unsymmetrical, thin and membranous, with entire margins; nervation fine and sparse, many pairs of lateral nerves being given off by the midrib (from which also spring many small lateral branchlets), and these arching upward inosculate near the margin or die out."

Collected by Dr. F. V. Hayden.

This is similar in nervation and in the general form of the lateral leaflets to the preceding species (*S. affinis*), but the whole plant is more delicate, the leaf thinner, the nervation finer, the terminal leaflet several times as large and of a different form.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Order RHAMNACEÆ.

Rhamnus elegans Newb.

Pl. L, fig. 2.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 49.

"Leaves lanceolate, entire, rounded or abruptly narrowed at the base, long-pointed and acute above, broadest part one-third the distance from the base to apex; nervation regular and sharp, but delicate; midrib strongly marked, lateral nerves twelve to fifteen, nearly equidistant on either side, gently arched upward, and terminating in the margins; tertiary nerves numerous, fine, spanning the distance between the branch nerves, and dividing this space into narrow, sub-rectangular areoles."

Collected by Miss Kate Haymaker.

This is a remarkably neat and symmetrical leaf, both as regards its outline and nervation. Its lines are all graceful, with little of the rigidity that characterizes the leaves of most of the Rhamnaceæ, and more of the aspect of the leaf of a Lauraceous tree; but the numerous parallel side-

nerves, terminating all in the margins, form a character which the Laurels never have.

Of described species it most resembles Weber's *R. Decheni* (Palæontogr. Vol. II, p. 204 [90], Pl. XXIII [VI], fig. 2), but differs from it in having an ovate, lanceolate form, and the nervation is a little more crowded.

Formation and locality: Cretaceous (Laramie group). Belmont, Colorado.

Rhamnus Eridani Ung.

Pl. XLVIII, fig. 7.

Gen. et Sp., Pl. Foss. (1850), p. 465.

The leaf represented in fig. 7 is unique in the collection made at Bridge Creek, Oregon, but though imperfect it is very distinctly marked, and apparently belongs to the genus Rhamnus, and so closely resembles some of the figures of *Rhamnus Eridani* Ung., especially that described in Fl. Foss. Arct, Vol. I, p. 123, Pl. XLIX, fig. 10, that I have not felt justified in regarding them as distinct.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Rhamnites concinnus Newb.

Pl. XXXIII, figs. 7 (8?).[1]

Ann. N. Y. Nat. Hist., Vol. IX (April, 1868), p. 50; Ills. Cret. and Tert. Pl. (1878), Pl. XVI, figs. 7, 9 (fig. 9 under *Viburnum asperum*).

"Leaves petioled, long ovate, acute, rounded at the base, coarsely and nearly equally mucronate-dentate; nervation pinnate, remarkably precise and parallel throughout; medial nerve straight; lateral nerves, nine to ten pairs, diverging at an angle of about 20 degrees, slightly arched upward, parallel among themselves, basilar pair reaching to margin below the middle of the leaf, sending off each about eight short, simple, slightly curved, parallel branches to the dentations of the baso-lateral margin; superior lateral nerves simple, or once-forked at the summit; tertiary nerves very numerous, simple, parallel, connecting the lateral secondary nerves and the branches of the basilar nerves nearly at right angles."

Collected by Dr. F. V. Hayden.

[1] The description applies without doubt to fig. 7, but does not agree with fig. 8. This latter specimen, however, is plainly labeled in Dr. Newberry's handwriting as belonging to this species, although it would appear to be more logical if allied with fig. 9, same plate (*Viburnum asperum* Newb.)—A. H.

These beautiful leaves are so definite in form and structure and so perfectly preserved that we should have no difficulty in referring them to their appropriate genus if we could find among living trees their precise generic counterpart, but up to the present time I have not been able to satisfy myself that they are generically related to any living plants. The nervation is in some respects very like that of Berchemia, e. g., *B. volubilis*, the "Supple Jack" of our Southern States. Nowhere else do I remember to have seen the same parallelism of the secondary and Tertiary nerves, but the serration of the margin is coarser than in any of the Rhamnaceæ with which I am acquainted, and the development of the basilar pair of lateral nerves is much greater than in Berchemia. This latter character is not without example in Rhamnus, as it is even more conspicuous in some species of the genus, as, for example, in *R. celtifolia* of the Cape of Good Hope. A cross between that species and our Berchemia, with a greater development of the marginal dentation than either exhibits, would give us the fossil before us.

Considering it to exhibit more of the character of the Rhamnaceæ than of any other family, I have placed it doubtfully there.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Zizyphus longifolia Newb.

Pl. LXV, figs. 3–5.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 513.

"Leaves 4 to 7 inches long by 6 to 12 lines wide; lanceolate, long-pointed, wedge-shaped at base, and long petioled; margins waved, or more or less distinctly toothed; midrib well defined from base to summit; basal pair of lateral nerves approaching closely to the margin near the middle of the leaf, then curving gently inward and anastomosing with the higher lateral nerves, of which there are three or more set alternately and curving upward, forming a festoon near the margin; tertiary nerves very finely reticulated."

Of this species a large number of specimens occur in the Green River Shales in certain layers where they are associated with the ferns Lygodium and Acrostichum They may be at once distinguished from those of any other described species of Zizyphus by their elongated and lanceolate form. In the same slabs which contain these leaves are a few which, though

imperfect, apparently represent Lesquereux's *Z. cinnamomoides*. These are ovate or ovate-lanceolate in outline, and yet may be only a variety of the species described above. They differ, however, widely from the description of *Z. cinnamomoides* of Lesquereux.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Order VITACEÆ.

Vitis rotundifolia Newb.

Pl. LI, fig. 2, in part; LIII, fig. 3.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 513.

"Leaf broadly rounded or sub-triangular in outline, cordate at the base, and with an acute point at the summit, and at the extremity of each of the angles; intermediate portions of the margin coarsely and bluntly toothed; strongly three-nerved; tertiary nervation distinct and flexuous."

Collected by Captain Howard.

The general aspect of this leaf is but imperfectly given in the drawings, inasmuch as the strength of the nervation has been somewhat exaggerated, but the leaf was apparently thicker and with stronger nervation than in most of the vines.

Among living species it bears the strongest resemblance to *V. labrusca*, but is less distinctly angled and more strongly dentate on the margin. Professor Heer has described three species of Vitis that occur in the arctic regions, *V. Olriki* (Fl. Foss. Arct., Vol. I, p. 120, Pl. XLVIII, fig. 1), *V. arctica* (*op. cit.*, Pl. XLVIII, fig. 2), and *V. Islandica* (*op. cit.*, p. 150, Pl. XXVI, figs. 1e, 1f, 7a), but all these had leaves which were more elongated triangles in form and of lighter structure.

Formation and locality: Tertiary (Miocene). Admiralty Inlet, Alaska.

Order TILIACEÆ.

Grewia crenata (Ung.) Heer.

Pl. XLVI, fig. 2; XLVIII, figs. 2, 3.

Fl. Tert. Helv., Vol. III (1859), p. 42, Pl. CIX, figs. 12–21; CX, figs. 1–11.
Dombeyopsis crenata Ung., Gen. et Sp. Pl. Foss. (1850), p. 448.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Order ARALIACEÆ.

Aralia macrophylla Newb.

Pl. LXVII, fig. 1; LXVIII, fig. 1.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 513.

"Leaves large, long-petioled, palmately five-parted from the middle upward, divisions conical in outline, sometimes entire, often remotely, occasionally coarsely toothed; nervation strong and regular; the midribs of the divisions strong and straight, those from the second lateral lobes springing from near the bases of the first lateral lobes; secondary nerves numerous, distinct, curved gently upward; where the margins are entire, partially camptodrome; where dentate, terminating in the teeth; tertiary nerves anastomosing to form quadrangular and very numerous areoles."

Collected by Dr. C. A. White.

In general form and nervation these leaves are very similar to the typical fossil species of the genus, viz: *A. Whitneyi* Lesq., *A. angostiloba* Lesq., of the Pliocene of California, and *A. Hercules* (Ung.) Sap. (Ann. Sci. Nat. Bot., 5^{me} Ser., Vol. IV, p. 295 [151], Pl. IX, fig. 2), of the Miocene of Radoboj, Croatia (*Platanus Hercules* Ung., Chlor. Prot., p. 138, Pl. XLVI), and especially *A. Saportanea* Lesq. of the Dakota Cretaceous. From all these, however, it differs specifically in several characters. Unger's species agrees in having the midribs of the lobes radiating from the base, while in the species described by Lesquereux, enumerated above, the lower pair spring from the first laterals some distance above their bases, as though the primary form was a tripartite leaf, the lateral lobes contracted where they join, thus acquiring a spatulate outline; and his *A. grandifolia* has more coarsely toothed, *A. Jatrophæfolia*, seven-parted leaves. In the localities where they are found the leaves of *A. macrophylla* are exceedingly abundant, sometimes matted together so as to obscure their outlines. These show that they vary in size, in the number of lobes, and in the character of the margins, occasionally one occurring which is only three-lobed, while almost all are five, and the margins are sometimes nearly entire, while in other leaves they are all strongly, even spinously dentate. The leaves vary from 3 to 12 inches in length, and the lobes are sometimes long and narrow,

in others much broader. This variability indicates that the leaves having narrow entire lobes found in the Dakota group and named *A. quinquepartita*, *A. tripartita*, and *A. cuneata*, by Mr. Lesquereux, are but forms of one species. *Aralia Whitneyi* Lesq. has seven-parted leaves, these less deeply lobed, and with entire margins; *A. angustiloba* more deeply cut leaves with narrower and entire lobes (Mem. Mus. Comp. Zoöl., Vol. VI, No. 2 (1878), p. 22, Pl. V, figs. 4, 5).

Perhaps of all described species of Aralias *A. Saportanea* Lesq., from the Dakota group of Kansas (U. S. Geol. and Geog. Surv. of Colorado, Hayden (1874), p. 350, Pl. I), approaches nearest to those under consideration, but are distinguished by minor characters, smaller size, less deeply dentate margins, etc. This species is found, however, in our Middle Cretaceous strata, forming part of the most ancient angiosperm flora, and while the species are unquestionably distinct, their great resemblance may be fairly taken as an indication that one is the progenitor of the other. The group of leaves now before us has been, perhaps without sufficient proof, referred to the genus Aralia, and it is highly desirable that this question should be decided by the discovery of fruit or flowers. But whether Aralia or not, they constitute a marked feature in the older angiosperm floras in this country and in Europe, and their geological interest and value is to a certain degree independent of their botanical relations. It has been suggested by Count Saporta that not only the trilobed leaves from the Dakota Cretaceous, which I have described as Sassafras, but also the great leaves of *Platanus nobilis*, figured in this volume, should be referred to Aralia, as the platanoid leaves described by Unger as *P. Hercules*, etc., have been; but there is little resemblance between the quinquepartite, narrow-lobed, toothed leaves of *A. Saportanea* Lesq. and its associates with three lobes, broadly rounded, sometimes almost obsolete and entire, in *Sassafras cretaceum*, and it only requires a glance at the figure of the huge leaf of *Platanus nobilis*, given on Pl. L of this monograph, to be satisfied that its affinities are with Platanus rather than Aralia.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Aralia (?) quinquepartita Lesq.

Pl. IX, fig. 1.

Hayden's Ann. Rept., 1871 [1872], p. 302; Cret. Fl. (1874), p. 90, Pl. XV, fig. 6.

The possession of a better specimen than that on which Lesquereux based the description of the species, one, in fact, that is nearly entire, prompts the publication of the figure now given.

Since the appearance of the Cretaceous Flora, Lesquereux has figured and described a number of species of Aralia (Report of Dr. F. V. Hayden, 1874, pp. 348, 349), of which his *Aralia concreta* and *A. tripartita* are perhaps only forms of the species under consideration.

Formation and locality: Cretaceous (Dakota group). Fort Harker, Kansas.

Aralia triloba Newb.

Pl. XL, figs. 4, 5.

Ann. N. Y. Lyc. Nat. Hist., ol. IX (April, 1868), p. 58; Ills. Cret. and Tert. Pl. (1878), Pl. XXV, figs. 4, 5.

"Leaves pinnate or ternate; lateral leaflets long-oval, rounded, or slightly heart-shaped, and unequal at base, pointed at summit, sharply serrate throughout; nervation pinnate; texture thin; surfaces smooth.

"Trilobate leaf similar in surface, texture, nervation, and marginal serration, but unequally three-lobed; lobes acute, long-pointed."

Collected by Dr. F. V. Hayden.

The character of these leaves is very well shown in the specimens before me. They seem to indicate a species of Aralia, and have a marked resemblance to some of the leaves of our two most common species, *A. racemosa* and *A. nudicaulis*. The trilobate leaf is not commonly found in our Aralias, but there is always a tendency to the production of such a form, and I have frequently remarked it in *A. racemosa*, as it grows at the West. That is, however, a larger and stronger plant than this was.

Formation and locality: Tertiary (Eocene?). Fort Clarke, Dakota.

Order CORNACEÆ.

Cornus Newberryi Hollick.[1]

Pl. XXXVII, figs. 2–4.

Cornus acuminata Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 71. (not *C. acuminata* Weber, Palæontogr., Vol. II (1852), p. 192); Ills. Cret. and Tert. Pl. (1878), Pl. XX, figs. 2–4, under *C. acuminata.*

"Leaves ovate or ovate-lanceolate, long-pointed, acute, entire, narrowed at the base, and slightly decurrent; midrib distinct, straight or curved toward the summit, following the course of the frequently deflexed point; lateral nerves numerous, regular, and nearly parallel, simple, lower ones straight with a slightly curved summit, upper ones becoming progressively more arched upwards, when near the apex of the leaf curved in so as nearly to join the extremity of the midrib; tertiary nervation so fine as to be hardly perceptible in the fossil state."

The specimens of these leaves contained in the collection of Dr. Hayden are quite numerous and pretty well preserved. Although there is no fruit of Cornus associated with them, there can be little doubt that they are properly referred to that genus. The aspect of the leaves of Cornus is peculiar, and such as is usually readily recognizable at a glance. This facies is given by the outline as well as the nervation. The outline is usually more or less accurately oval, the margin entire, the base rounded or slightly wedge-shaped, the summit pointed and laterally flexed. The nervation is very clearly defined, the midrib strong at the base, tapering gradually till it reaches the extreme point of the apex; the lateral nerves pinnate, approximated below, more remote above; all simple, arched upward, those near the summit being drawn in to join the midrib.

This latter characteristic is visible in all the species of Cornus known and is particularly noticeable in the common herbaceous species of *C. Canadensis.* It is also very marked in *C. Florida, C. sericea, C. alternifolia,* etc.

The tertiary nervation is generally delicate and sparse, the tertiary branchlets running across obliquely, but with nearly a straight course, between the adjacent lateral nerves. In all these characters, as far as they

[1] Dr. Newberry's original published name, *C. acuminata* (1868), was antedated by Weber's, *C. acuminata* (1852), given to another species. It therefore became necessary to change the name.—A. H.

are retained in the fossils before us, we find an entire correspondence with the living genus Cornus, and refer these leaves to that place in the botanical series with as much confidence as the foliary appendages alone can give.

Lesquereux suggests that this plant is identical with his *Juglans rhamnoides* (Tert. Fl., p. 284), but after a careful comparison of specimens I am compelled to consider them as distinct. The nervation of these leaves is that of Cornus and not of Juglans, and no species of the latter genus has the long, strong petiole on which the blade is decurrent, as in the specimens before us.

Formation and locality: Tertiary (Eocene?) Fine laminated sandstone, with *Platanus Haydenii* and *Populus Nebrascencis.* Yellowstone River, Montana.

Nyssa (?) cuneata Newb.

Pl. XVII, figs. 4–6.

Ficus ? cuneatus Newb. Bost. Journ. Nat. Hist., Vol. VII (1863), p. 524.

"Leaves obovate or elliptical, shortly acuminate at summit, wedge-shaped at base, decurrent onto the petiole; nervation distinct, flexuous, reticulated; midrib strong; lateral nerves eight or nine pairs gently arched upward, the lower ones curved at the extremities, anastomosing near the margin, the upper ones forked above the branches, meeting and forming a coarse network."

The specimens of this plant are too few and two obscurely preserved to permit any accurate determination; for the present it may be left in the genus Nyssa, to some species of which it certainly bears a close resemblance, both in outline and nervation.

Formation and locality: Cretaceous (Puget Sound group). Orcas Island, Washington.

Nyssa vetusta Newb.

Pl. I, fig. 2; IV, fig. 4.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 11; Ills. Cret. and Tert. Pl. (1878), Pl. II, fig. 2, under *Magnolia obovata.*

Magnolia obovata Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 15; Ills. Cret. and Tert. Pl. (1878), Pl. IV, fig. 4.

"Leaves large, obovate, entire, thick, and smooth, pointed and slightly decurrent on the petiole; nervation strong; midrib straight and extending

to the summit; lateral nerves pinnate, set at somewhat unequal distances, straight and parallel below, forked and inosculating above, forming a festoon parallel with the margin; tertiary nerves forming an irregular network of polygonal and relatively large areoles."

Collected by Dr. F V. Hayden.

Of this species there are numerous specimens in the collections made by Dr. Hayden in as good preservation as the material in which they are fossilized will permit. The nervation is strongly marked, and all its more prominent characters as appreciable in the fossil as they were in the fresh leaves. In nervation, consistence, and outline these leaves are almost undistinguishable from those of the "Pepperidge" (*Nyssa multiflora*). The primary and secondary nervation of some species of Magnolia also exhibit a strong resemblance to that of these fossils, but a less complete correspondence than Nyssa presents. Without the fruit, or at least leaves preserved in a fine argillaceous sediment in which the finer details of nervation are given, the affinity suggested must be to some extent conjectural.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Order SAPOTACEÆ.

Sapotacites Haydenii Heer.

Pl. V, fig. 1.

Proc. Acad. Nat. Sci. Phil. (1858), p. 265; Ill. Cret. and Tert. Pl. (1878), Pl. V, fig. 1.

Professor Heer compares this leaf with one described by him in his Flora Tertiaria Helvetiæ under the name of *S. mimusops*. He further described it as "diminishing toward the base, rounded toward the apex, rather deeply emarginate. From the midrib, which gradually becomes slender and dies out, proceed at acute angles very numerous secondary nerves, which have the peculiarity of ramifying very much."

This is one of the leaves described by Professor Heer from tracings sent him by Mr. Meek, and the specimen now figured is that from which the tracing was made. As it has not before been figured, and is frequently referred to in the earlier discussions of the flora of the Dakota group, it has seemed desirable that a figure should be given of it so that it may be iden-

tified. The original tracing of Mr. Meek, on which Professor Heer wrote the name given to the leaf, as well as the original, are before me as I write, so there can be no mistake about the identification of the species. I have seen no other specimens than this one, and have nothing to add to the description given by Professor Heer, except that the emargination of the summit is in part at least the result of fracture and may not be a constant character. The peculiar crowded nervation will serve to distinguish this leaf from the others described by Professor Heer and noticed elsewhere (*Leguminosites Marcouanus* and *Phyllites obcordatus*), both of which have similar obovate outlines and emarginate summits.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Order OLEACEÆ.

Fraxinus affinis Newb.

Pl. XLIX, fig. 5.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 510.

"Leaves petioled, lanceolate, long-pointed, attenuate at base; margins coarsely and irregularly toothed at and above the middle."

Collected by Rev. Thomas Condon.

This leaf has almost precisely the form, serration, and nervation of some folioles of *F. Americana* now living, but it is narrower and has a more crowded nervation than the average leaflets of that species.

Among fossil ashes this approaches closely to *F. excelsifolia* Webb. (Palæontogr. IV, p. 150, Pl. XXVII, fig. 3), but the dentation in that species is much coarser and the nervation more remote.

Professor Heer has described two species of Fraxinus (*F. predicta* and *F. denticulata*), both of which Lesquereux thinks he has identified among the Tertiary leaf impressions obtained from the West. The fragments he figures, however, are too imperfect for the identification of the species. They are both described by Professor Heer as sessile, while the leaf before us is distinctly petioled.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon

Fraxinus denticulata Heer?.

Pl. XLIX, fig. 6.

Fl. Foss. Arct., Vol. I (1868), p. 118, Pl. XVI, fig. 4.

Note.—The only manuscript which I have found relating to this figure is a marginal note on the plate referring it to "*Fraxinus dentata* Heer?," evidently meaning *F. denticulata*, and the specimen label giving the locality.—A. H.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Fraxinus integrifolia Newb.

Pl. XLIX, figs. 1–3.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 509.

"Leaves short-petioled or sessile; lanceolate; broadest near the base, which is abruptly narrowed and wedge-shaped; summit narrowed, extremity rounded; margins entire; nervation reticulate, camptodrome; lateral branches connected in elegant festoons near the margins; intervals filled with a network of roundish, polygonal meshes."

Collected by Rev. Thomas Condon.

These leaves have been referred with some doubt to Fraxinus, but the nervation is almost exactly like that of *F. prædicta* Heer (Fl. Tert. Helv. III, p. 22, Pl. CIV, figs. 12 to 13g), and the general form is similar, except that in that species the folioles are unsymmetrical and are generally more or less dentate.

Formation and locality: Tertiary (Miocene). Bridge Creek, Oregon.

Order CAPRIFOLIACEÆ.

Viburnum antiquum (Newb.) Hollick.[1]

Pl. XXXIII, figs. 1, 2.

Tilia antiqua Newb. Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 52; Ills. Cret. and Tert. Pl. (1878), Pl. XVI, figs. 1, 2, under *Tilia antiqua*.

Viburnum tilioides Ward. Bull. U. S. Geol. Surv. No. 37 (1887), p. 107, Pl. L, figs. 1–3; LI, figs. 1–8; LII, figs. 1, 2.

"Leaves 4 to 5 inches long, nearly as wide, often somewhat unsymmetrical, cordate at base, abruptly acuminate at summit, coarsely and

[1] This species was referred to the genus Tilia, by Dr. Newberry, in his original description, but Dr. Lester F. Ward has clearly shown that it belongs in the genus Viburnum.—A. H.

nearly equally toothed; nervation strong, medial nerve straight, bearing eight or nine pairs of lateral nerves, which diverge at an angle of about 45 degrees. The basilar pair of lateral nerves each sending off five or six branches on the lower side, which are again branched and terminate in the teeth of the margin. The second pair of lateral nerves have each four similar branches, the third pair three, the fourth pair two, the fifth pair one, though there are frequent departures from this rule. The tertiary nerves are strongly marked, leaving the secondary nerves nearly at right angles, crossing directly between the adjacent ones, or anastomosing with some irregularity in the middle of the interspaces."

Collected by Dr. F. V. Hayden.

There are many fragments of these leaves in the collection before me, embedded in a very fine and hard argillaceous limestone, and very beautifully preserved. They exhibit considerable resemblance to the leaves of Morus, especially *M. rubra*, but in that plant the basilar nerves of the leaves are more developed and reach the margins higher up. The marginal dentation is also generally more acute in the leaves of the mulberry and the leaves more pointed. The nervation of these fossil leaves is almost precisely that of our common species of Tilia, but in that the marginal dentation is much sharper. In a Southern species, however, *T. heterophylla*, I have found leaves which seem to be the exact counterpart of these; leaves with a roughish surface, strong and regular nervation, just after this pattern, and with a coarse, obtuse, and regular dentation. I am, therefore, inclined to refer these fossils to Tilia, and to regard them as the relics of a species closely allied to, if not identical with, *T. heterophylla*.

Formation and locality: Tertiary (Eocene?). Near Fort Clarke, Dakota.

Viburnum asperum Newb.

Pl. XXXIII, fig. 9.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 54; Ills. Cret. and Tert. Pl. (1878), Pl. XVI, fig. 8.

"Leaves ovate in outline, rounded or slightly cordate at base, acute and long-pointed above, margins all cut by relatively large acute teeth; nervation strong, crowded; midrib straight; lateral nerves alternate, about nine on each side, the lowest and strongest bearing each five to six simple branches on the lower side; the lateral nerves of the middle of the leaf

carrying one to two branches at the summits, the upper ones simple, all terminating in the marginal teeth; tertiary nerves numerous, connecting the secondaries nearly at right angles, and generally parallel."

Collected by Dr. F. V Hayden.

The nervation of these leaves is strong, regular, and crowded. The marginal serration is simple, coarse, and sharp, much like that of the leaves of many species of Viburnum.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Viburnum cuneatum Newb.

Pl. LVII, fig. 2.

Proc. U. S. Nat. Mus., Vol. V (March 21, 1883), p. 511.

"Leaves petioled, long-obovate, 10 centimeters or more in length by 4 centimeters in width; margins entire below the middle; above, set with coarse sub-acute or acute teeth; nervation strong, simple; midrib straight, giving off at an acute angle seven or eight simple, strong nerve branches on either side, which terminate in the teeth of the margin."

Collected by Dr. F. V. Hayden.

The general aspect of this peculiar leaf is as much like that of Cornus as Viburnum, and if the basal portion alone were shown, few botanists would doubt the propriety of referring it to Cornus. But the upper part of the leaf is very strongly dentate, the simple strong nerve branches terminating in these teeth, a character unknown in the species of Cornus, living or fossil. Some species of Viburnum exhibit a somewhat similar nervation and the dentate margin is much more in character here than in Cornus. It has been thought best, therefore, to refer it provisionally to Viburnum, a genus which seems to have been quite prevalent in late Cretaceous and Tertiary times on this continent, running into a great number of distinct species.

It is true, however, that the lateral nerves in the leaves of Viburnum are always branched, though in some specimens of *Viburnum dentatum* perhaps only one or two of the branches in a leaf give off branchlets. The dentation is quite that of *V. dentatum.* Further collections, which will undoubtedly be made in the region where this leaf was found, will doubtless determine to which of these genera these belong, the counterbalancing

characters of nervation and margin leaving it a question which it is now impossible to decide.

Formation and locality: Tertiary (Eocene?). Tongue River, Montana.

Viburnum lanceolatum Newb.

Pl. XXXIII, fig. 10.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 54; Ills. Cret. and Tert. Pl. (1878), Pl. XVI, fig. 10.

"Leaves small, narrow, ovate or ovate-lanceolate, rounded or slightly wedge-shaped at the base, pointed above, coarsely and sharply serrate-dentate throughout; nervation strong; midrib straight; lateral nerves about five pairs, diverging from the midrib at an angle varying from 15 to 20 degrees, all slightly and uniformly arched upward, the basilar pair each throwing out at an acute angle about six simple branches, which terminate in the teeth of the margin, the upper branches supporting each one or two similar branches near the summits; tertiary nervation fine, and undistinguishable in the fossil state."

Collected by Dr. F. V. Hayden.

In the regularity and precision of the nervation these leaves resemble those of Carpinus, but in most species of that genus the serration of the margins is double, while here it is single, and, except in one or two Old World forms, the nervation of the leaves of the living species of that genus is considerably different, the basilar pair of lateral nerves being much shorter and simple or less branched.

The style of nervation observable in these fossils occurs in one or two species of Rhamnus, but is there very exceptional, and the marginal serration of Rhamnus is rarely, if ever, so coarse as in the plant before us.

In Zizyphus we have a similar nervation, and not a dissimilar style in Celtis, but in neither of these have we such marginal teeth. In Viburnum, however, we have some examples of leaves exhibiting a closer resemblance to the fossils than any I have cited above, as in *Viburnum erosum* Thunbg., from Korea, and *V. odoratissimum* of Japan. In both these plants we find leaves with a great development of the basilar pair of nerves, and a coarse, acute, and regular dentation of the margin.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

DICOTYLEDONEÆ OF UNCERTAIN AFFINITIES.

Protophyllum minus Lesq.

Pl. IX, fig. 3.

Cret. Fl. (1874), p. 104, Pl. XIX, fig. 2; XXVII, fig. 1.

Note.—So identified by Dr. Newberry, as indicated by memorandum on margin of plate.—A. H.

Formation and locality: Cretaceous (Dakota group). Fort Harker, Kansas.

Protophyllum multinerve Lesq.

Pl. VII, fig. 4.

Cret. Fl. (1874), p. 105, Pl. XVIII, fig. 1.
Pterospermites multinervis Lesq. Hayden's Ann. Rept. 1871 [1872], p. 302.

The figure now given shows the basal portion of a leaf which may have been 6 inches in diameter. It is intended to exhibit its peculiar sub-peltate character by which it may be at once recognized. More or less complete leaves of this species are quite common in the Cretaceous rocks of Kansas, and a large number are in my possession. None of these are absolutely perfect, but some are so nearly so as to permit me to add something to the description given by Lesquereux.

The leaf when in normal form was nearly orbicular, being slightly pointed above, uniformly rounded at the base, and evidently somewhat cupped by the interior insertion of the petiole. The margin was entire or slightly undulate, the nerves strong, regular, approximately parallel, camptodrome, the branches terminating in the prominences of the margin where it is undulate.

The resemblance of these leaves to those obtained from the Tertiary of Greenland and described by Heer under the name of *Pterospermites* (*P. dentatus*, *P. integrifolius*, *P. spectabilis*, and *P. alternans*) is very striking and gives presumptive evidence of botanical affinity.

The large leaves brought by Dr. W. H. Dall from Alaska and figured on Pls. LIII and LIV evidently belong in the same category and may not be specifically different from Heer's *P. spectabilis*. No satisfactory conclusion, however, can be reached in regard to the relations of this group of leaves until the fruits belonging to the same tree shall be found.

Formation and locality: Cretaceous (Dakota group). Fort Harker, Kansas.

Protophyllum Sternbergii Lesq.

Pl. X; XI.

Cret. Fl. (1874), p. 101, Pl. XVI; XVIII, fig. 2.
Pterospermites Sternbergii Lesq. Hayden's Ann. Rept. 1872 [1873], p. 425.

The specimens figured on Pls. X and XI represent but parts of some of these magnificent angiospermous leaves found in the Dakota group of Kansas. They apparently represent Lesquereux's *P. Sternbergii*, but are perhaps not distinct from those described by him first as *Credneria Lecontiana*, and subsequently *Protophyllum Lecontianum*.

The leaf figured on Pl. X seems to have been nearly round and at least 12 inches in diameter; that represented on Pl. XI was more ovate and was still larger. Both were included in the collections made at Fort Harker by Mr. Charles H. Sternberg, and Lesquereux has done only justice to him by attaching his name to the finest species contained in the large collection of fossil plants which he made there.

As previously remarked, no satisfactory relationship has been established between Protophyllum and living genera of plants, but I would suggest that some of the species of Cocoloba, such as *C. pubescens*, present many points of similarity of structure.

Formation and locality: Cretaceous (Dakota group). Fort Harker, Kansas.

Pterospermites dentatus Heer.

Pl. LIII, figs. 1, 2; LIV, fig. 4.

Fl. Foss. Arct., Vol. I (1868), p. 138, Pl. XXI, fig. 15b; XXIII, figs. 6, 7.

The leaves here represented are probably not distinct from those described by Professor Heer under the above name, although the fragment which he had did not permit him to give a full characterization or satisfactory figures. His description consists of three words: "*Foliis, sub-peltatis, dentatis*," all of which is true of the much more complete specimens before us, but they also show that the base of the leaf is entire, or nearly so, the upper margin variably dentate or nearly entire. These specimens also show that the leaves of *P. dentatus*—if we acccept that name for the

species—are variable in size, in the strength of the nervation, and in their degree of perfoliation. Hence it is highly probable that the three species described by Professor Heer from the arctic regions, namely, that cited above, and his *P. spectabilis* and *P. alternans* (Fl. Foss. Arct., Vol. II, Abth. IV, p. 480, Pl. XLIII, fig. 15b; LIII, figs. 1–4, and LIV, fig 3), will ultimately be combined in one.

The specimens before us were brought by Mr. W. H. Dall from the Yukon River, in Alaska. They show that the plant which bore them was of strong, luxuriant growth, probably a tree of large size. No other species is immediately associated with this in the collection made by Mr. Dall, but the formation in which it occurs is undoubtedly of the same age with that at Cooks and Admiralty inlets—the so-called Arctic Miocene—and this tree formed a part of the luxuriant vegetation which included the gigantic *Quercus Grönlandica*, *Ficus Alaskana*, etc., and covered Alaska in Tertiary times.

Formation and locality: Tertiary (Miocene). Yukon River, Alaska.

Phyllites carneosus Newb.

Pl. XLI, figs. 1, 2.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 75; Ills. Cret. and Tert. Pl. (1878), Pl. XXVI, figs. 1, 2.

"Leaves large, fleshy, and strongly nerved, orbicular in outline, cordate or rounded, often unsymmetrical at the base, obtuse at summit, margins wavy or coarsely and deeply scalloped; nervation strongly marked throughout; medial nerve straight, or nearly so, frequently produced into a long and strong petiole; lateral nerves in six to eight pairs, all more or less forked; lower pair short and curving downward soon after leaving the midrib; second pair also curved outward near the base, and reaching the baso-lateral margin by a course nearly at right angles to the line of the midrib; third pair strongest, much branched on the lower side above the middle; upper pairs once or twice forked near the summit; tertiary nerves parallel, simple, straight or gently arched, given off at right angles from the secondary, which they connect."

Collected by Dr. F. V. Hayden.

Up to the present time I have failed to identify these leaves with those of any genus known, living or fossil. In general form they resemble

those of Coccoloba, and must have belonged to some plant having much the habit of *C. uvifera;* but the leaves of that plant are entire, and the nervation is quite different. One of the other species of Coccoloba, which grows in the West Indies, *C. diversifolia,* has leaves with a marginal serration, and a nervation more like that of the leaves before us, but both margins and nerves are unlike.

The leaves which I have designated by the name of *Phyllites cupanioides,* as it seems to me, should be generically united with these.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Phyllites cupanioides Newb.

Pl. XLI, figs. 3, 4.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 74; Ills. Cret. and Tert. Pl. (1878), Pl. XXVI, figs. 3, 4, under *P. venosus.*

"Leaves large, fleshy, ovate, elliptical in outline, rounded at base, sub-acute at summit, margins coarsely and obtusely toothed above, simple or waved below; nervation pinnate, strong; midrib straight or flexuous, lateral nerves, about six on each side, crowded below, more remote above, basilar pair short and simple, uniting above with the tertiary branches of the second pair to form a marginal festoon, middle secondaries each bearing one or two branches near the summits, upper one simple; tertiary nervation distinct, forming lattice-like bars connecting the secondary nerves at right angles."

These fine leaves exhibit a resemblance in their texture and crenate margins to those to which I have given the name of *Phyllites carneosus.* They are, however, of different form, and have more simple and rectilinear nervation. The collection of Dr Hayden contains a great number of fragments of this species, but up to the present time I have failed to find among living plants any which afford a satisfactory comparison with them. A general similarity in form and nervation to Cupania, and especially to *C. Americana,* has suggested the name adopted, but it can not be said that the correspondence is very close.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Phyllites obcordatus Heer.

Pl. V, fig. 2.

Proc. Phil. Acad. Nat. Sci., 1858, p. 266; Ills. Cret. and Tert. Pl. (1878), Pl. V, fig. 2, under *Leguminosites Marcouanus.*

This is the leaf described by Professor Heer from a tracing by Mr. Meek and figured in Dana's Manual of Geology with the name *Leguminosites Marcouanus,* and described and figured by Lesquereux in his Cretaceous Flora, page 90, Pl. XXVIII, fig. 2, under the name of *Bumelia Marcouana.* The original tracing now before me, bearing Professor Heer's name written with his own hand, renders the identification easy and certain, and shows, as remarked elsewhere, that the names of this and the associated obovate emarginate leaf have been interchanged. Lesquereux, supposing that Professor Heer had applied the name Leguminosites to this leaf, which he has shown to be long-petioled, and therefore almost certainly not belonging to a leguminous plant, changed the name to Bumelia, but as mentioned elsewhere, the name Leguminosites was applied to another leaf, and this must stand as Phyllites until some good reason can be given for transferring it to another genus, and in that case it would be necessary to retain the specific name *obcordatus.*

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Phyllites Vanonæ Heer.

Pl. III, fig. 8.

Nouv. Mem. Soc. Helv. Sci. Nat., Vol. XXII (1866), p. 22, Pl. I, fig. 8; Ills. Cret. and Tert. Pl. (1878), Pl. III, fig. 8, under *Diospyros primæva.*

Note.—So identified by Dr. Newberry, as indicated by memorandum on specimen and margin of plate.—A. H.

Formation and locality: Cretaceous (Dakota group). Blackbird Hill, Nebraska.

Phyllites venosus Newb.

Pl. XXX, fig. 4.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 75; Ills. Cret. and Tert. Pl. (1878), Pl. XXIV, fig. 4.

"Leaves thick and fleshy, irregularly oval in outline, rounded or slightly heart-shaped at base, blunt-pointed above, unsymmetrical throughout, mar-

gins entire or serrate, nervation strong, pinnate, midrib flexuous, lateral nerves arched upward, branching at summit."

Collected by Dr. F. V. Hayden.

I have been able to detect no relationship between these leaves and those of any living plants, and publish the figures and description given in hopes that others may be more successful. They have the general aspect of those of a Lauraceous tree, but I suspect they are related to those now described under the names of *P. carneosus* and *P. cupanioides*.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Nordenskioldia borealis Heer.

Pl. LXVIII, figs. 4–6.

Fl. Foss. Arct., Vol. II, Abth. III (1870), p. 65, Pl. VII, figs. 1–13.

Professor Heer describes a capsulary dry fruit which he has called by the name given above. It occurs in groups, is spheroidal, dehiscent, with ten to twelve carpels of which the section is wedge-shaped, the smaller angle turned inward to a central vertical axis. Professor Heer compares this fruit with that of *Cistus ladaniferus*, to which it has a general resemblance. It was collected at Cape Staratschin (Spitzbergen) with *Nymphæa arctica* and fragments of Phragmites and of Sparganium; also at Atanekerdluck (Greenland). From its associates in Spitzbergen it would seem to be the fruit of an aquatic plant. In the Green River Shales Dr. White has collected numerous specimens which are apparently identical with those described by Heer. Some of these are grouped in such a way that it is evident that the fruit was compound; that is, a number were aggregated in a spike or crowded panicle, while the scattered capsules represented in our figs. 5 and 6 are distinctly pedunculated and apparently terminated in a rostrum, the prolongation of a central axis.

After a somewhat extended comparison with the fruits of various plants, I am compelled to question the conclusion that these have any botanical affinity with Cistus, and it seems to me the plant here represented was more likely allied to Allisma. By the examination of the fruit of our *Alisma plantago* it will be seen to be a rounded head, flattened or excavated above, consisting of a number of triangular capsules combined precisely as in the Nordenskioldia. This resemblance, taken in connection with the apparent

aquatic habit of the plant, justifies at least a conjecture that we have in these fruits relics of an allismoid plant larger and stronger than our living *Alisma plantago*, but further collections will be needed to justify or disprove this inference.

Formation and locality: Tertiary (Green River group). Green River, Wyoming.

Carpolithes spinosus Newb.

Pl. LXVIII, figs. 2, 3.

Proc. U. S. Nat. Mus., Vol. V (March 31, 1883), p. 514.

"Fruit enclosed in an exocarp composed of three elliptical or lentiform segments, furrowed along the middle line of the dorsum and bristling with erect, acute spines 6 to 8 millimeters long; peduncle cylindrical, strong, 1 inch or more in length."

Collected by Prof. I. C. Russell.

A figure is given of this fruit because of its remarkable character rather than with the hope of establishing its botanical relations. Its occurrence associated with many palm leaves and its tripartite division afford presumptive evidence that it belongs to the palms, but no living palm fruit suggests itself as an analogue. Apparently all that we see here is a husk or envelope which probably inclosed an elliptical nut that was partially protected by the bristling spines of the outer surface.

Formation and locality: Cretaceous (Laramie group). North Branch of Purgatory River, Colorado.

Carpolithes lineatus Newb.

Pl. XL, fig. 1.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 31 (name only); Ills. Cret. and Tert. Pl. (1878), Pl. XXV, fig. 1.

Note.—The only manuscript which was found relating to this figure is a memorandum of the name and locality on the plate margin. The following description was prepared from an examination of the figure: Fruit rounded, elliptical in outline, five-eighths inch long by one-half inch wide, beaked, finely striate in direction of greater dimension.—A. H.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

Calycites polysepala Newb.

Pl. XL, fig. 3.

Ann. N. Y. Lyc. Nat. Hist., Vol. IX (April, 1868), p. 31 (name only); Ills. Cret. and Tert. Pl. (1878), Pl. XXV, fig. 3.

Note.—The only manuscript which was found relating to this species is a memorandum of the name and locality, on the plate margin, in Dr. Newberry's handwriting.

The following description was prepared from an examination of the figure: Organism calyx-like, sub-circular in outline, about $1\frac{1}{4}$ inches in diameter, consisting of six divisions (sepals ?), each of which is about three-eighths inch long by three-sixteenths inch wide at base, tapering to an acute point.—A. H.

Formation and locality: Tertiary (Fort Union group). Fort Union, Dakota.

TABLE OF DIS

List of species, showing locali

	Page of this work.	Species.	Raritan River, New Jersey, Raritan Formation.	Smoky Hill, Kansas, Dakota group.	Fort Harker, Kansas, Dakota group.	Blackbird Hill, Nebraska, Dakota group.	Big Sioux River, Nebraska, Dakota group.	Cedar Spring, Nebraska, Dakota group.	Decatur, Nebraska, Dakota group.	Rio Dolores, Utah, Dakota group.	Whetstone Creek, New Mexico, Dakota group.	Sage Creek, South Dakota, Dakota group (?).	Keyport, New Jersey, Mattewan Formation.	Nanaimo, Vancouvers Island, Puget Sound group.	Chuckanuts, Washington, Puget Sound group.	Bellingham Bay, Washington, Puget Sound group.	Point of Rocks, Wyoming, Montana Formation.	Vermejo Canyon, New Mexico, Laramie group.	Fischers Peak, Colorado, Laramie group.	Raton Mountains, Colorado, Laramie group.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1	Lygodium Kaulfussi Heer																		
2	3	Anemia perplexa Hollick														+	+			
3	6	Acrostichum hesperium Newb																		
4	7	Pteris pennæformis Heer ?																		
5	7	Pteris Russellii Newb																+		
6	8	Onoclea sensibilis fossilis Newb																		
7	10	Lastrea (Goniopteris) Fischeri Heer?																		
8	11	Aspidium Kennerlyi Newb												+						
9	12	Pecopteris (Cheilanthes) sepulta Newb																		
10	14	Sphenopteris corrugata Newb				+														
11	14	Equisetum Oregonense Newb																		
12	15	Equisetum robustum Newb														+				
13	15	Equisetum Wyomingense Lesq																		
14	16	Equisetum sp. ? Newb																		
15	16	Nilssonia Gibbsii (Newb.) Hollick														+				
16	17	Araucaria spatulata Newb										+								
17	18	Abietites cretacea Newb									+									
18	18	Sequoia cuneata Newb												+			+			
19	19	Sequoia gracillima (Lesq.) Newb	+								+		+							
20	20	Sequoia Heerii Lesq																		
21	20	Sequoia Nordenskioldii Heer?																		
22	21	Sequoia spinosa Newb																		
23	22	Taxodium distichum miocenum Heer																		
24	23	Taxodium occidentale Newb																		
25	24	Glyptostrobus Europæus (Brong.) Heer																		
26	25	Thuja interrupta Newb																		
27	27	Phragmites sp.? Newb																		
28	27	Sabal Campbelli Newb														+				

TRIBUTION.

ties mentioned in the text.

	Purgatory River, Colorado, Laramie group.	Walsenburg, Colorado, Laramie group.	Florence, Colorado, Laramie group.	Erie, Colorado, Laramie group.	Coal Basin, Colorado, Laramie group.	Belmont, Colorado, Laramie group.	Marshalls, Colorado, Laramie group.	Black Butte, Wyoming, Laramie group.	Hams Fork, Wyoming, Laramie group.	Carbon, Wyoming, Laramie group (?).	Spring Canyon, Montana, Livingston Formation.	Golden, Colorado, Denver Formation, Laramie group.	Carbonado, Washington, Eocene.	Fletts Creek, Washington, Eocene.	Henrys Fork, Utah, Eocene (?).	Amil Creek, North Dakota (?), Eocene (?).	La Boutes Creek, Nebraska, Eocene (?).	Fort Berthold, North Dakota, Fort Union group.	Fort Clark, North Dakota, Fort Union group.	Fort Union, North Dakota, Fort Union group.	Yellowstone River, Montana, Fort Union group.	Tongue River, Montana, Fort Union group (?).	Green River, Wyoming, Green River group.	Dalles of the Columbia, Oregon, Miocene (?).	Florissant, Colorado, Miocene.	McBees Canyon, Oregon, Miocene.	Currant Creek, Oregon, Miocene.	Bridge Creek, Oregon, Miocene.	Cooks Inlet, Alaska, Miocene.	Admiralty Inlet, Alaska, Miocene.	Yukon River, Alaska, Miocene.	Kootznahoo, Alaska, Miocene.	Birch Bay, Washington, Miocene.	Locality not known.	
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52		
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List of species, showing localities

	Page of this work.	Species.	Raritan River, New Jersey, Raritan Formation.	Smoky Hill, Kansas, Dakota group.	Fort Harker, Kansas, Dakota group.	Blackbird Hill, Nebraska, Dakota group.	Big Sioux River, Nebraska, Dakota group.	Cedar Spring, Nebraska, Dakota group.	Decatur, Nebraska, Dakota group.	Rio Dolores, Utah, Dakota group.	Whetstone Creek, New Mexico, Dakota group.	Sage Creek, South Dakota, Dakota group. (?)	Keyport, New Jersey, Mattewan Formation.	Nanaimo, Vancouvers Island, Puget Sound group.	Chuckanuts, Washington, Puget Sound group.	Bellingham Bay, Washington, Puget Sound group.	Point of Rocks, Wyoming, Montana Formation.	Vermejo Canyon, New Mexico, Laramie group.	Fischers Peak, Colorado, Laramie group.	Raton Mountains, Colorado, Laramie group.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
29	28	Sabal grandifolia Newb																	+	
30	30	Sabal imperialis Dn												+						
31	30	Sabal Powellii Newb																		
32	31	Manicaria Haydenii Newb																		
33	32	Smilax cyclophylla Newb																		
34	33	Iris sp.? Newb																		
35	33	Monocotyledon gen. et sp.? Hollick																		
36	33	Juglans nigella Heer																		
37	34	Juglans occidentalis Newb																		
38	35	Carya antiquorum Newb																		
39	37	Myrica trifoliata Newb									+									
40	37	Populus acerifolia Newb																		
41	38	Populus cordata Newb																		
42	40	Populus (?) cordifolia Newb				+														
43	41	Populus cuneata Newb																		
44	41	Populus cyclophylla Heer			+	+														
45	42	Populus (?) Debeyana Heer				+														
46	43	Populus elliptica Newb				+														
47	44	Populus flabellum Newb													+					
48	44	Populus genetrix Newb																		
49	45	Populus litigiosa Heer			+	+														
50	46	Populus microphylla Newb				+														
51	47	Populus Nebrascencis Newb																		
52	48	Populus nervosa Newb																		
53	49	Populus nervosa elongata Newb																		
54	50	Populus polymorpha Newb																		
55	51	Populus rhomboidea Lesq												+						
56	51	Populus rotundifolia Newb																		
57	53	Populus smilacifolia Newb																		

mentioned in the text—Continued.

| | | |

List of species, showing localities

	Page of this work.	Species.	Raritan River, New Jersey, Raritan Formation.	Smoky Hill, Kansas, Dakota group.	Fort Harker, Kansas, Dakota group.	Blackbird Hill, Nebraska, Dakota group.	Big Sioux River, Nebraska, Dakota group.	Cedar Spring, Nebraska, Dakota group.	Decatur, Nebraska, Dakota group.	Rio Dolores, Utah, Dakota group.	Whetstone Creek, New Mexico, Dakota group.	Sage Creek, South Dakota, Dakota group (?).	Keyport, New Jersey, Mattewan Formation.	Nanaimo, Vancouvers Island, Puget Sound group.	Chuckanuts, Washington, Puget Sound group.	Bellingham Bay, Washington, Puget Sound group.	Point of Rocks, Wyoming, Montana Formation.	Vermejo Canyon, New Mexico, Laramie group.	Fischers Peak, Colorado, Laramie group.	Raton Mountains, Colorado, Laramie group.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
58	54	Populites elegans Lesq.?			+															
59	54	Salix angusta Al. Br.?																		
60	55	Salix cuneata Newb					+													
61	56	Salix flexuosa Newb				+	+	+			+									
62	57	Salix foliosa Newb.									+									
63	58	Salix Meekii Newb.				+			+											
64	59	Salix membranacea Newb	+																	
65	59	Carpinus grandis Ung																		
66	60	Corylus Americana fossilis Newb																		
67	61	Corylus MacQuarrii (Forbes) Heer																		
68	62	Corylus orbiculata Newb.																		
69	63	Corylus rostrata fossilis Newb																		
70	63	Betula angustifolia Newb																		
71	64	Betula heterodonta Newb																		
72	65	Betula sp.? Newb																		
73	65	Alnus Alaskana Newb																		
74	66	Alnus serrata Newb																		
75	66	Alnus serrulata fossilis Newb																		
76	67	Alnus sp.? Newb																		
77	67	Alnites grandifolia Newb				+														
78	68	Fagus cretacea Newb		+																
79	69	Quercus antiqua Newb								+										
80	69	Quercus banksiæfolia Newb													+					
81	70	Quercus castanoides Newb																		
82	71	Quercus castanopsis Newb																		
83	71	Quercus consimilis Newb																		
84	73	Quercus coriacea Newb													+					
85	73	Quercus dubia Newb																		
86	74	Quercus elliptica Newb													+					

mentioned in the text—Continued.

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	
Purgatory River, Colorado, Laramie group.																																			58
Walsenburg, Colorado, Laramie group.																																			59
Florence, Colorado, Laramie group.																																			60
Erie, Colorado, Laramie group.																																			61
Coal Basin, Colorado, Laramie group.																																			62
Belmont, Colorado, Laramie group.																																			63
Marshalls, Colorado, Laramie group.																																			64
Black Butte, Wyoming, Laramie group.																																			65
Hams Fork, Wyoming, Laramie group.																																			66
Carbon, Wyoming, Laramie group (?).																																			67
Spring Canyon, Montana, Livingston Formation.																																			68
Golden, Colorado, Denver Formation, Laramie group.																																			69
Carbonado, Washington, Eocene.																																			70
Fletts Creek, Washington, Eocene.																																			71
Henrys Fork, Utah, Eocene (?).																																			72
Amil Creek, North Dakota (?), Eocene (?).																																			73
La Bontes Creek, Nebraska, Eocene (?).																																			74
Fort Berthold, North Dakota, Fort Union group.																																			75
Fort Clark, North Dakota, Fort Union group.																																			76
Fort Union, North Dakota, Fort Union group.																																			77
Yellowstone River, Montana, Fort Union group.																																			78
Tongue River, Montana, Fort Union group (?).																																			79
Green River, Wyoming, Green River group.																																			80
Dalles of the Columbia, Oregon, Miocene (?).																																			81
Florissant, Colorado, Miocene.																																			82
McBees Canyon, Oregon, Miocene.																																			83
Currant Creek, Oregon, Miocene.																																			84
Bridge Creek, Oregon, Miocene.																																			85
Cooks Inlet, Alaska, Miocene.																																			86
Admiralty Inlet, Alaska, Miocene.																																			
Yukon River, Alaska, Miocene.																																			
Kootzahoo, Alaska, Miocene.																																			
Birch Bay, Washington, Miocene.																																			
Locality not known.																																			

List of species, showing localities

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			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
87	74	Quercus flexuosa Newb.													+					
88	75	Quercus gracilis Newb.															+			
89	75	Quercus Grönlandica Heer.																		
90	76	Quercus laurifclia Newb.																		
91	76	Quercus paucidentata Newb.																		
92	77	Quercus salicifolia Newb.				+														
93	78	Quercus simplex Newb.																		
94	78	Quercus sinuata Newb.								+										
95	79	Quercus Sullyi Newb.																		
96	80	Ulmus speciosa Newb.																		
97	81	Planera crenata Newb.																		
98	81	Planera longifolia Lesq.																		
99	81	Planera microphylla Newb.																		
100	82	Planera nervosa Newb.																		
101	83	Planera variabilis Newb.																		
102	84	Celtis parvifolia Newb.																		
103	84	Ficus (?) Alaskana Newb.																		
104	85	Ficus asarifolia minor Lesq.															+			
105	85	Ficus (?) Condoni Newb.																		
106	87	Ficus membranacea Newb.																		
107	88	Ficus planicostata Lesq.																		
108	88	Ficus reticulata (Lesq.) Hollick			+	+														
109	89	Protofícus inæqualis Newb.																		
110	90	Aristolochia cordifolia Newb.																		
111	91	Cabomba (?) gracilis Newb.																		
112	92	Cabomba inermis (Newb.) Hollick																		
113	93	Brasenia (?) antiqua Newb.																		
114	94	Magnolia alternans Heer?				?														
115	94	Magnolia elliptica Newb.																		

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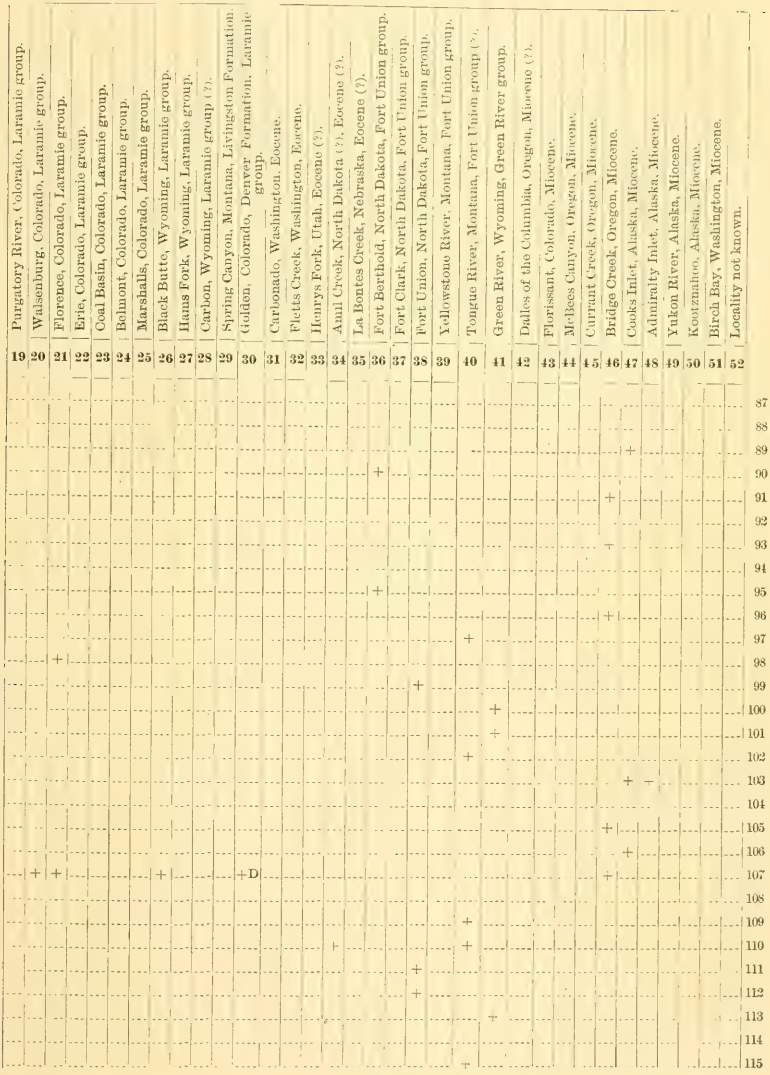

List of species, showing localities

	Page of this work.	Species.	1 Raritan River, New Jersey, Raritan Formation.	2 Smoky Hill, Kansas, Dakota group.	3 Fort Harker, Kansas, Dakota group.	4 Blackbird Hill, Nebraska, Dakota group.	5 Big Sioux River, Nebraska, Dakota group.	6 Cedar Spring, Nebraska, Dakota group.	7 Decatur, Nebraska, Dakota group.	8 Rio Dolores, Utah, Dakota group.	9 Whetstone Creek, New Mexico, Dakota group.	10 Sage Creek, South Dakota, Dakota group (?).	11 Keyport, New Jersey, Mattewan Formation.	12 Nanaimo, Vancouvers Island, Puget Sound group.	13 Chuckanuts, Washington, Puget Sound group.	14 Bellingham Bay, Washington, Puget Sound group.	15 Point of Rocks, Wyoming, Montana Formation.	16 Vermejo Canyon, New Mexico, Laramie group.	17 Fischers Peak, Colorado, Laramie group.	18 Raton Mountains, Colorado, Laramie group.
116	94	Magnolia obovata Newb				+														
117	95	Magnolia rotundifolia Newb																	+	
118	95	Liriodendron Meekii Heer				+														
119	96	Liriodendron primævum Newb				+				•										
120	97	Berberis simplex Newb																		
121	98	Sassafras cretaceum Newb		+	+	+														
122	99	Sassafras cretaceum recurvatum (Lesq.) Newb			+															
123	100	Cinnamomum Heerii Lesq															+			
124	100	Liquidambar Europæum Al. Br																		
125	101	Liquidambar obtusilobatus (Heer) Hollick			+	+														
126	102	Platanus aspera Newb																		
127	103	Platanus Haydenii Newb																		
128	105	Platanus latiloba Newb				+														
129	106	Platanus nobilis Newb																		
130	109	Platanus Raynoldsii Newb																		
131	110	Pyrus cretacea		+																
132	111	Amelanchier similis Newb																		
133	112	Cratægus flavescens Newb																		
134	112	Prunus variabilis Newb																		
135	113	Cassia sp.? Newb																		
136	113	Leguminosites Marcouanus Heer				+											•			
137	114	Rhus (?) nervosa Newb															•			
138	115	Acer sp.? Newb																		
139	115	Negundo triloba Newb																		
140	116	Sapindus affinis Newb																		
141	117	Sapindus (?) membranaceus Newb																		
142	117	Rhamnus elegans Newb			•															
143	118	Rhamnus Eridani Ung																		
144	118	Rhamnites concinnus Newb																		

mentioned in the text—Continued.

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	46	41	42	43	44	45	46	47	48	49	50	51	52	
Purgatory River, Colorado, Laramie group.																																			116
Walsenburg, Colorado, Laramie group.																																			117
Florence, Colorado, Laramie group.																																			118
Erie, Colorado, Laramie group.																																			119
Coal Basin, Colorado, Laramie group.																												+							120
Belmont, Colorado, Laramie group.						+																													121
Marshalls, Colorado, Laramie group.							+																												122
Black Butte, Wyoming, Laramie group.																																			123
Hams Fork, Wyoming, Laramie group.																												+							124
Carbon, Wyoming, Laramie group (?).																																			125
Spring Canyon, Montana, Livingston Formation.																												+							126
Golden, Colorado, Denver Formation, Laramie group.								+?				+D									+														127
Carbonado, Washington, Eocene.																																			128
Flutts Creek, Washington, Eocene.																																			129
Henrys Fork, Utah, Eocene (?).								+?				+D									+														130
Amil Creek, North Dakota (?), Eocene (?).																																			131
La Bontes Creek, Nebraska, Eocene (?).																																			132
Fort Berthold, North Dakota, Fort Union group.																																			133
Fort Clark, North Dakota, Fort Union group.																																			134
Fort Union, North Dakota, Fort Union group.																																			135
Yellowstone River, Montana, Fort Union group.																																			136
Tongue River, Montana, Fort Union group (?).																																			137
Green River, Wyoming, Green River group.																																			138
Dalles of the Columbia, Oregon, Miocene (?).																																			139
Florissant, Colorado, Miocene.																																			140
McBees Canyon, Oregon, Miocene.																																			141
Currant Creek, Oregon, Miocene.																																			142
Bridge Creek, Oregon, Miocene.																																			143
Cooks Inlet, Alaska, Miocene.																																			144
Admiralty Inlet, Alaska, Miocene.																																			
Yukon River, Alaska, Miocene.																																			
Kootznahoo, Alaska, Miocene.																																			
Birch Bay, Washington, Miocene.																																			
Locality not known.																																			

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			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
145	119	Zizyphus longifolia Newb																		
146	120	Vitis rotundifolia Newb																		
147	120	Grewia crenata (Ung.) Heer																		
148	121	Aralia macrophylla Newb																		
149	123	Aralia (?) quinquepartita Lesq			+															
150	123	Aralia triloba Newb																		
151	124	Cornus Newberryi Hollick																		
152	125	Nyssa (?) cuneata Newb														+				
153	125	Nyssa vetusta Newb				+														
154	126	Sapotacites Haydenii Heer				+														
155	127	Fraxinus affinis Newb																		
156	128	Fraxinus denticulata Heer?																		
157	128	Fraxinus integrifolia Newb																		
158	128	Viburnum antiquum (Newb.) Hollick																		
159	129	Viburnum asperum Newb																		
160	130	Viburnum cuneatum Newb																		
161	131	Viburnum lanceolatum Newb																		
162	132	Protophyllum minus Lesq			+															
163	132	Protophyllum multinerve Lesq			+															
164	133	Protophyllum Sternbergii Lesq			+															
165	133	Pterospermites dentatus Heer																		
166	134	Phyllites carneosus Newb																		
167	135	Phyllites cupanioides Newb																		
168	136	Phyllites obcordatus Heer				+														
169	136	Phyllites Vanonæ Heer			+	+														
170	136	Phyllites venosus Newb																		
171	137	Nordenskioldia borealis Heer																		
172	138	Carpolithes spinosus Newb																		
173	138	Carpolithes lineatus Newb																		
174	139	Calycites polysepala Newb																		

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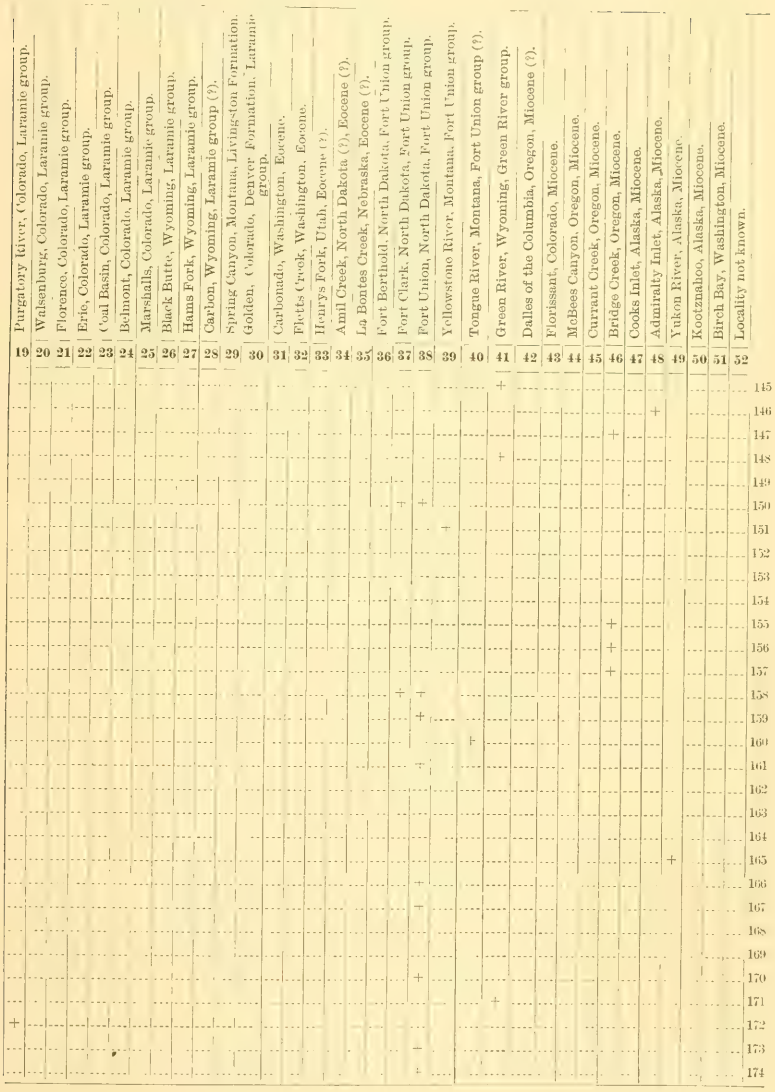

PLATES.

PLATE I.

PLATE I.

Page.

FIG. 1. Quercus salicifolia Newb 77
2. Nyssa vetusta Newb 125
3. Fagus cretacea Newb 68
4. Platanus latiloba Newb 105
5, 5a. Araucaria spatulata Newb 17
6. Sphenopteris corrugata Newb 14
7. Pyrus cretacea Newb 110

Sinclair & Son, Lith

PLATE II.

PLATE II.

		Page.
FIGS. 1, 2.	Salix cuneata Newb.	55
3.	Salix Meekii Newb.	58
4.	Salix flexuosa Newb.	56
5–8a.	Salix membranacea Newb	59

PLATE III.

PLATE III.

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FIGS. 1, 2. Populus elliptica Newb 43
3, 4. Populus cyclophylla Heer 41
5. Populus microphylla Newb 46
6. Populus litigiosa Heer 45
7. Populus (?) cordifolia Newb 40
8. Phyllites Vanonæ Heer 136

CRETACEOUS.
(Dakota Group.)

Thos. Sinclair & Son, Lith.

PLATE IV.

PLATE IV.

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FIG. 1. Populus cyclophylla Heer 41
2. Alnites grandifolia Newb 67
3. Populus (?) Debeyana Heer 42
4. Nyssa vetusta Newb 125

CRETACEOUS.
(Dakota Group.)

Jos. Sinclair & Son, Lith.

PLATE V.

PLATE V.

		Page.
FIG. 1	Sapotacites Haydenii Heer	126
2.	Phyllites obcordatus Heer	136
3.	Leguminosites Marcouanus Heer	113
4.	Liquidambar obtusilobatus (Heer) Hollick	101
5.	Populus (?) cordifolia Newb	40
6.	Magnolia alternans Heer?	94
7.	Populus (?) Debeyana Heer	42

PLATE VI.

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FIGS. 1–4. Sassafras cretaceum Newb. 98

5, 6. Liriodendron Meekii Heer. 95

7. Liriodendron primævum Newb. 96

PLATE VII.

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FIGS. 1–3. Sassafras cretaceum Newb. 98

4. Protophyllum multinerve Lesq 132

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PLATE VIII.

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FIGS. 1, 2. Sassafras cretaceum Newb. 98

3. Populites elegans Lesq? 54

170

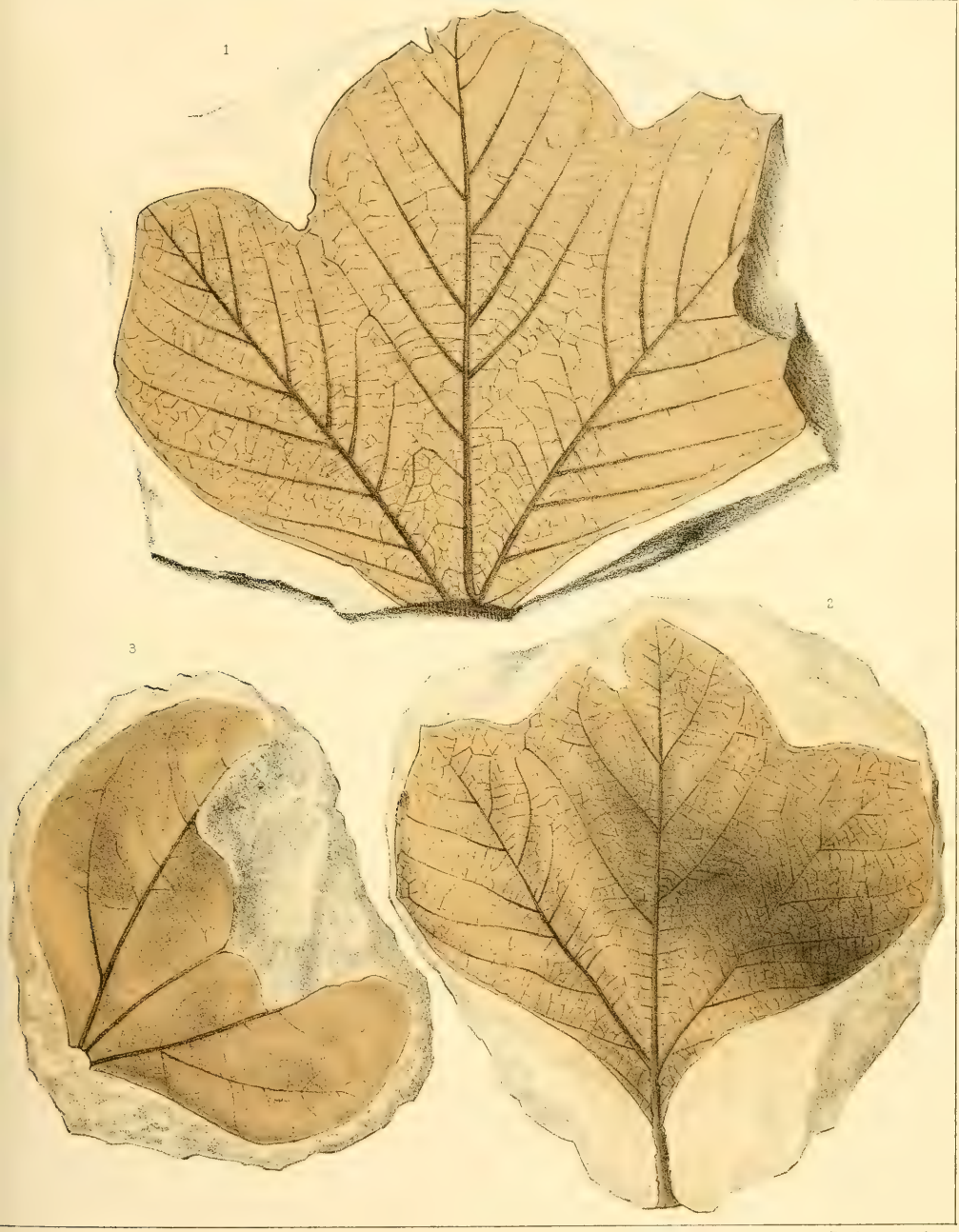

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PLATE IX.

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FIG. 1. Aralia (?) quinquepartita Lesq. 123
2. Sassafras cretaceum recurvatum (Lesq.) Newb. 99
3. Protophyllum minus Lesq. 132

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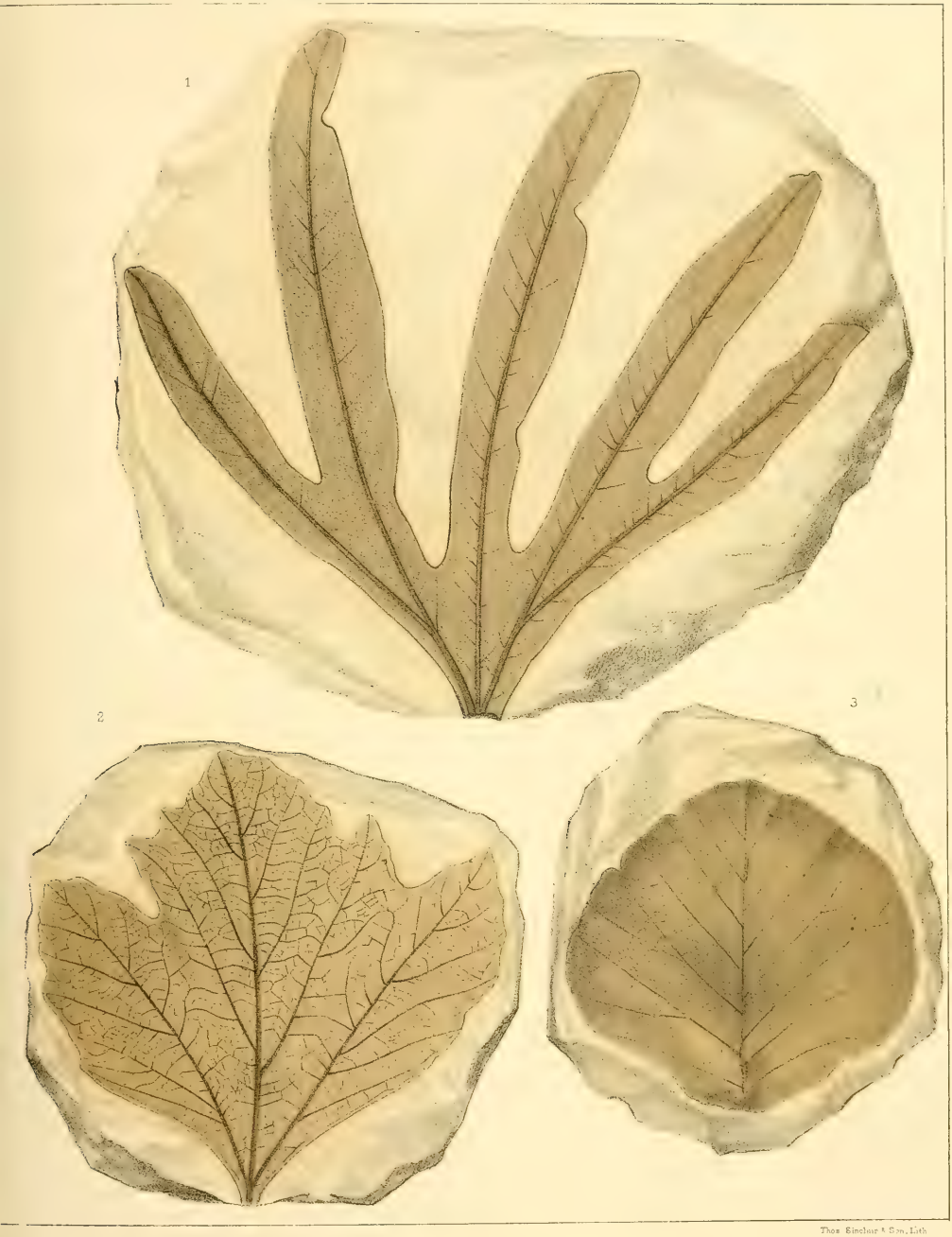

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PLATE X.

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Protophyllum Sternbergii Lesq 133
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PLATE XI.

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Protophyllum Sternbergii Lesq 133
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PLATE XII.

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FIG. 1. Magnolia elliptica Newb 94

2, 3. Ficus reticulata (Lesq.) Hollick 88

4. Liquidambar obtusilobatus (Heer) Hollick 101

CRETACEOUS.
(Dakota Group.)

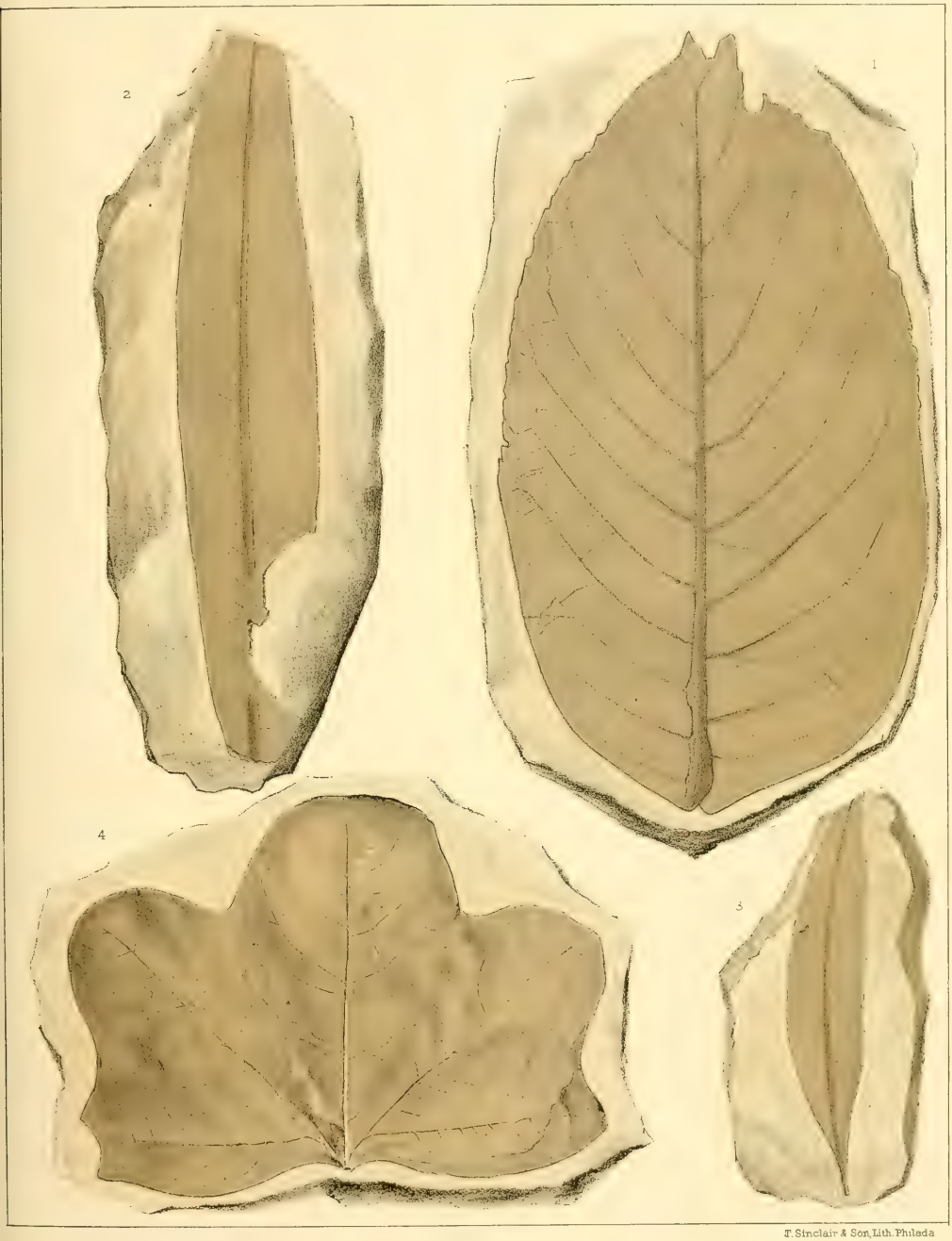

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PLATE XIII.

PLATE XIII.

		Page.
FIG. 1.	Quercus sinuata Newb	78
2.	Quercus antiqua Newb	69
3, 4.	Salix flexuosa Newb	56
5, 6.	Salix foliosa Newb	57

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PLATE XIV.

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FIG. 1. Salix flexuosa Newb 56
2. Myrica (?) trifoliata Newb 37
3–4a. Sequoia cuneata Newb 18
5 Abietites cretacea Newb 18
6. Sequoia gracillima (Lesq.) Newb 19

T. Sinclair & Son, lith. Philada.

PLATE XV.

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FIGS. 1, 1a. Anemia perplexa Hollick 3

2, 2a. Nilssonia Gibbsii (Newb.) Hollick 16

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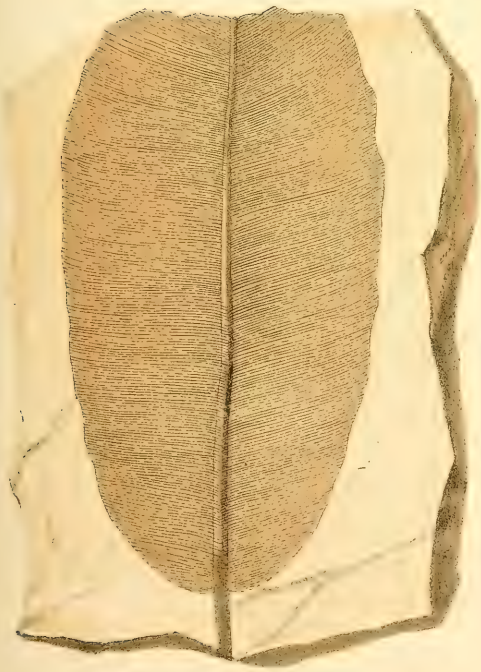

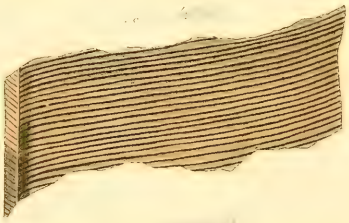

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PLATE XVI.

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FIGS. 1, 2. Equisetum robustum Newb. 15

3. Anemia perplexa Hollick 3

4, 5. Aspidium Kennerlyi Newb 11

6, 6a. Sabal imperialis Dn 30

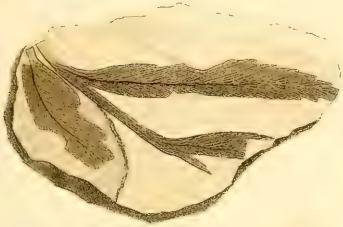

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PLATE XVII.

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FIGS. 1–3. Cinnamomum Heerii Lesq 100

4–6. Nyssa (?) cuneata Newb 125

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PLATE XVIII.

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FIG. 1. Quercus elliptica Newb 74

2–5. Quercus banksiæfolia Newb 69

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PLATE XIX.

PLATE XIX.

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FIGS. 1–3. Quercus coriacea Newb 73
4–6. Quercus flexuosa Newb 74

Lon. Sinclair & Son, Lith

PLATE XX.

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FIGS. 1, 2. Populus rhomboidea Lesq. 51
3. Quercus elliptica Newb. 74
4. Populus flabellum Newb. 44
5. Quercus coriacea Newb. 73

Thos. Sinclair & Son, Lith

PLATE XXI.

PLATE XXI.

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FIGS. 1, 2. Sabal Campbelli Newb..... 27
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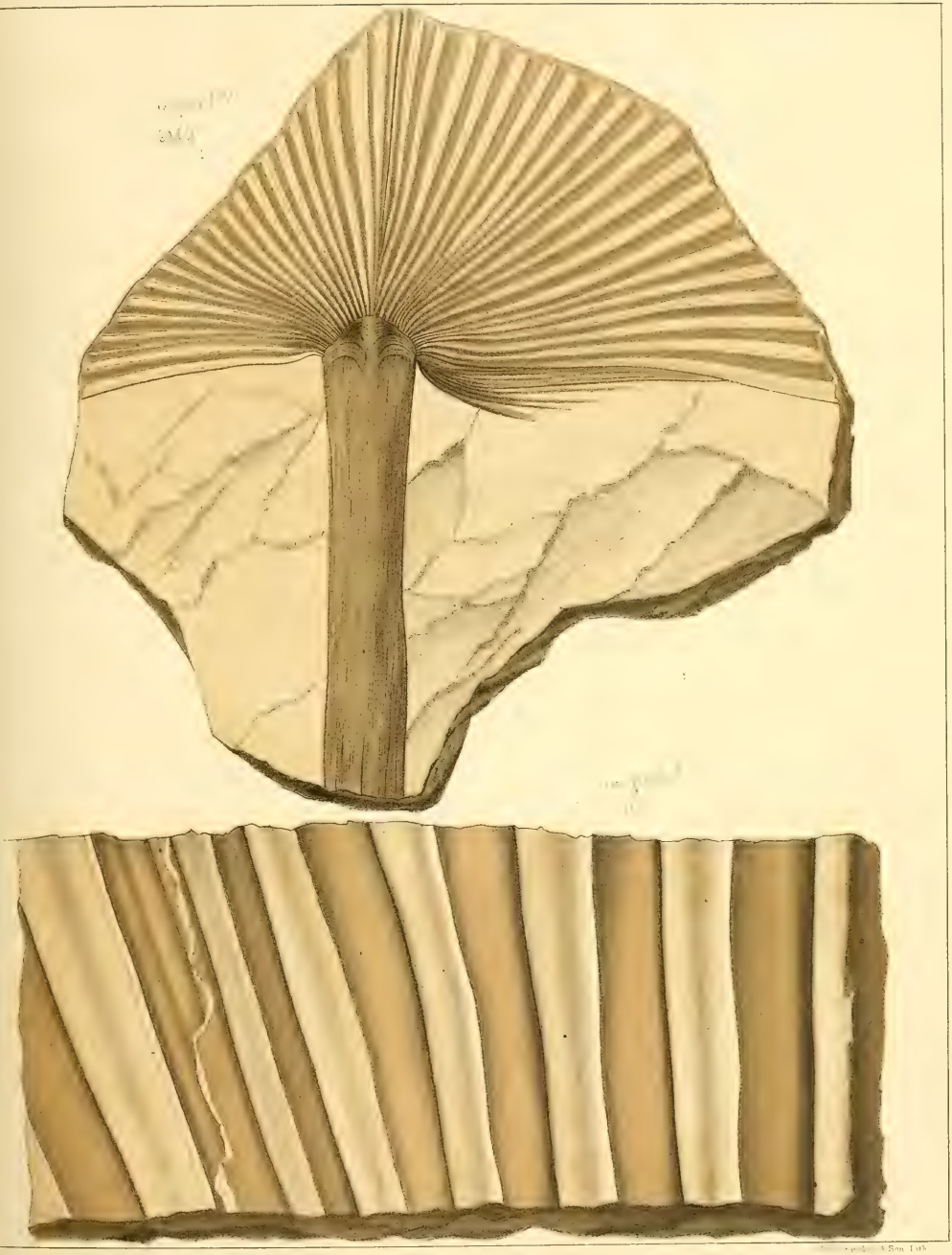
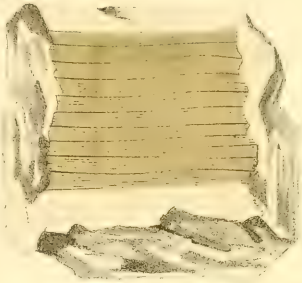
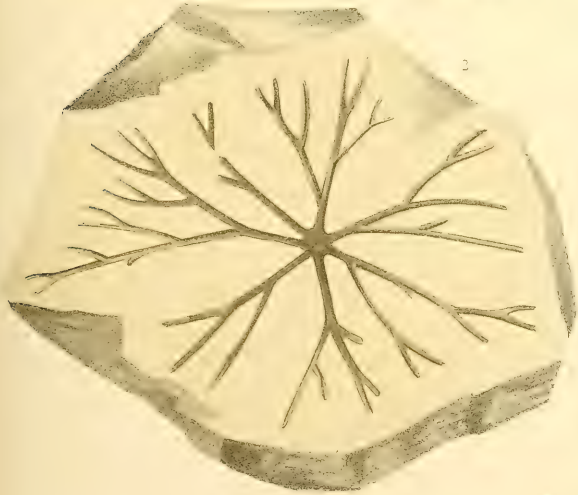


PLATE XXII.

PLATE XXII.

		Page.
FIG.	1. Cabomba (?) gracilis Newb	91
	2. Cabomba inermis (Newb.) Hollick	92
	3, 4. Equisetum sp. ? Newb	16
	5, 5a. Phragmites sp. ? Newb	27
	6. Iris sp. ? Newb	33





T. Sinclair & Son, Lith. Philada

PLATE XXIII.

PLATE XXIII.

Page.

FIG. 1. Cabomba(?) gracilis Newb. 91
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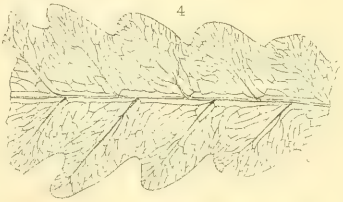

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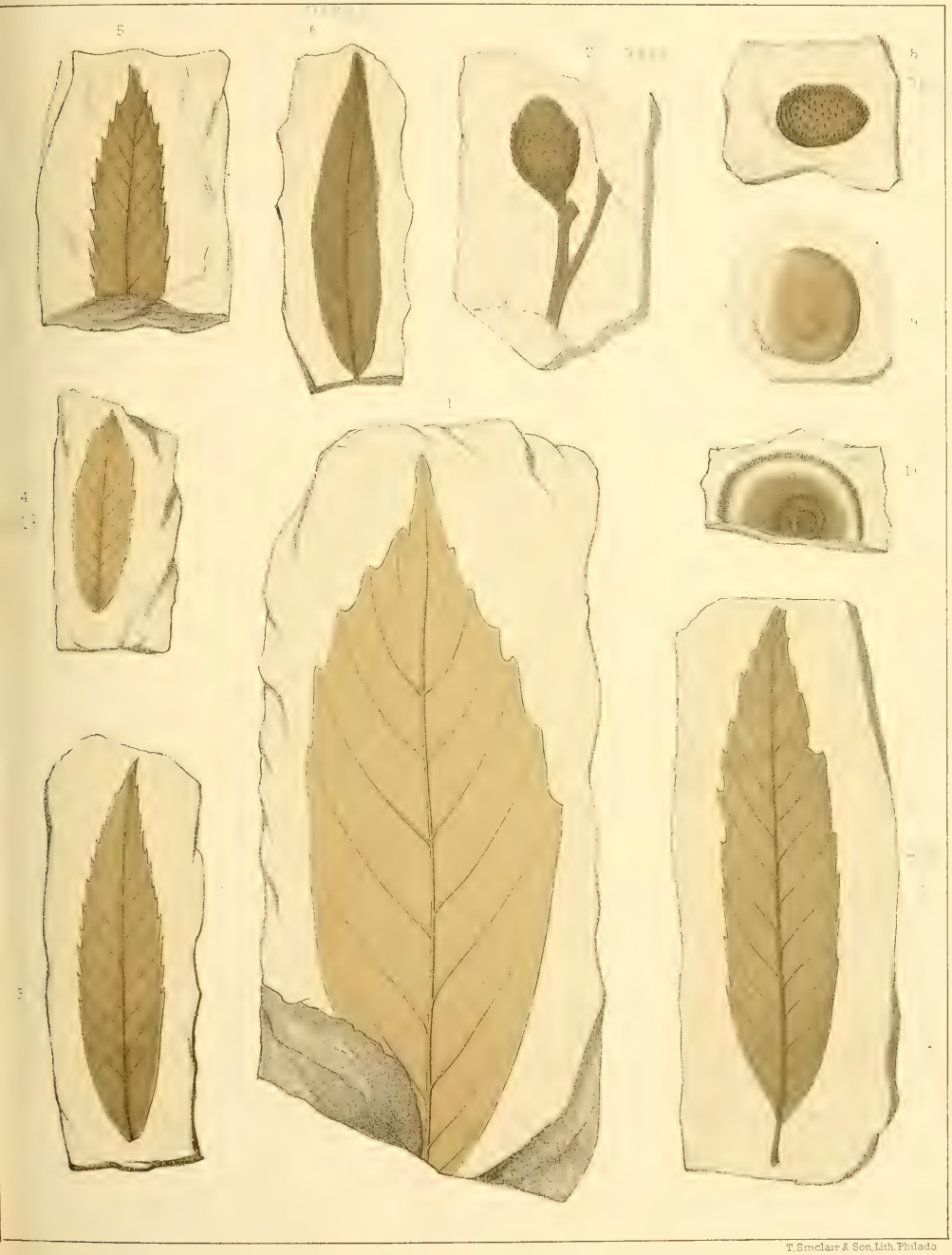

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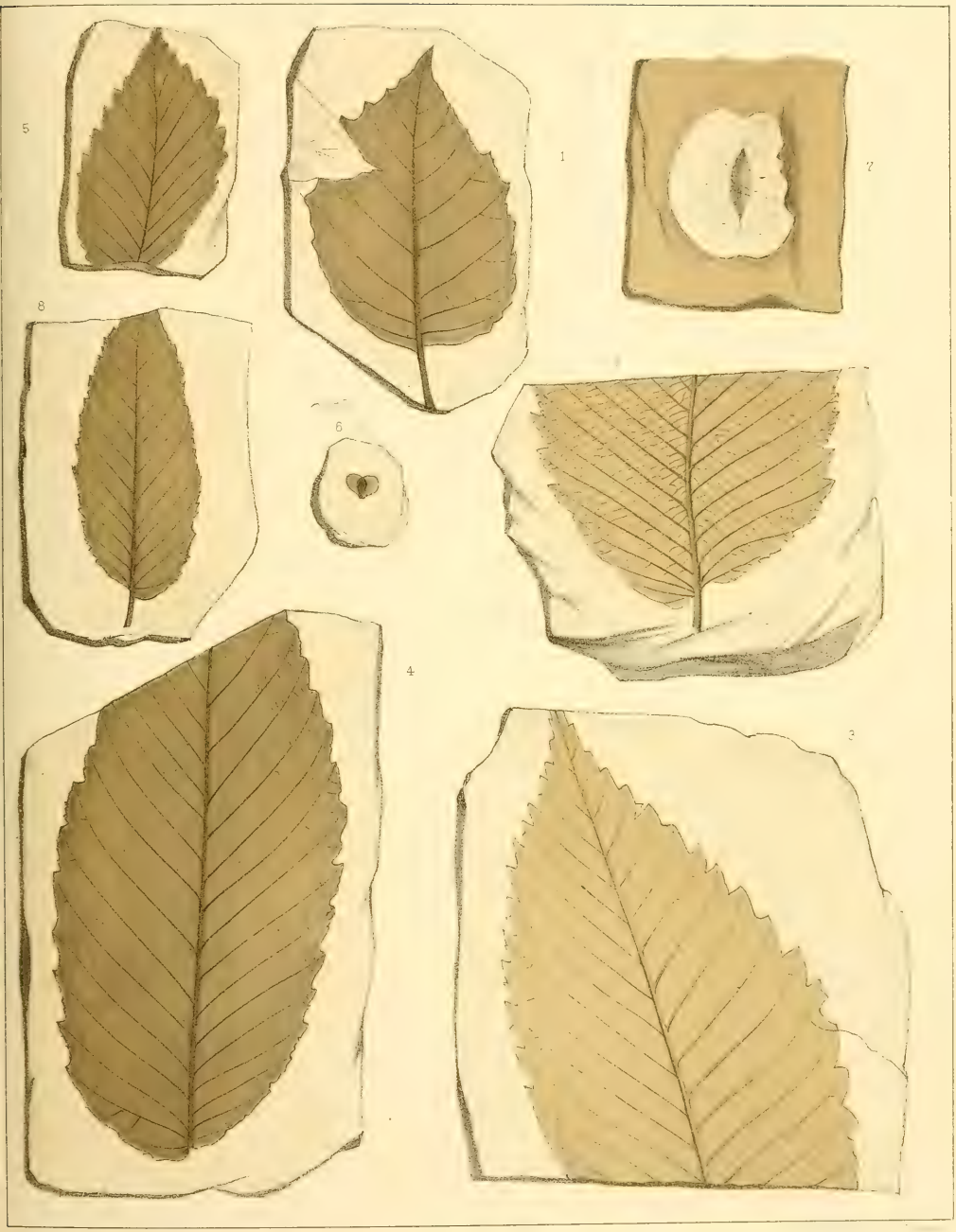
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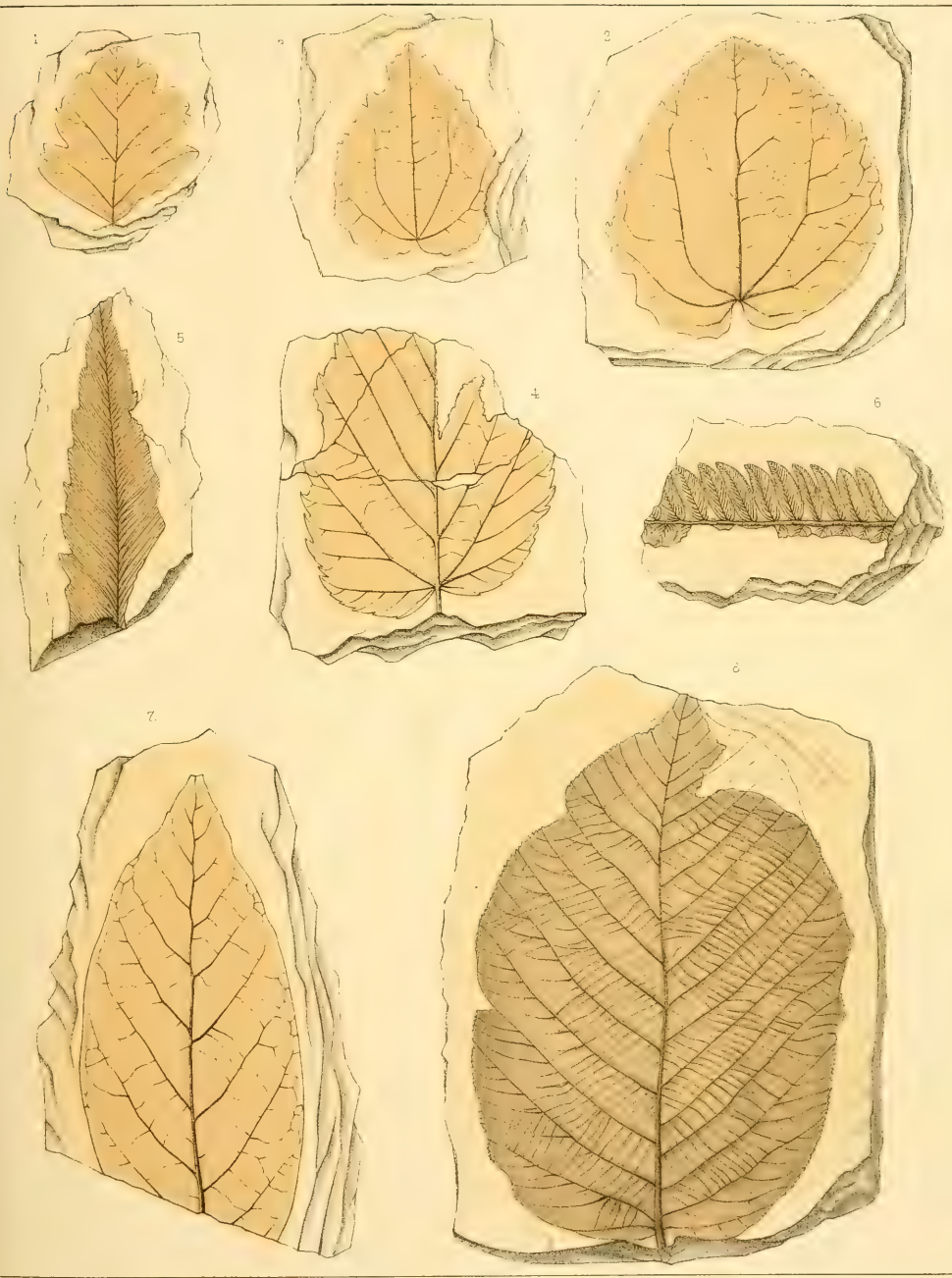

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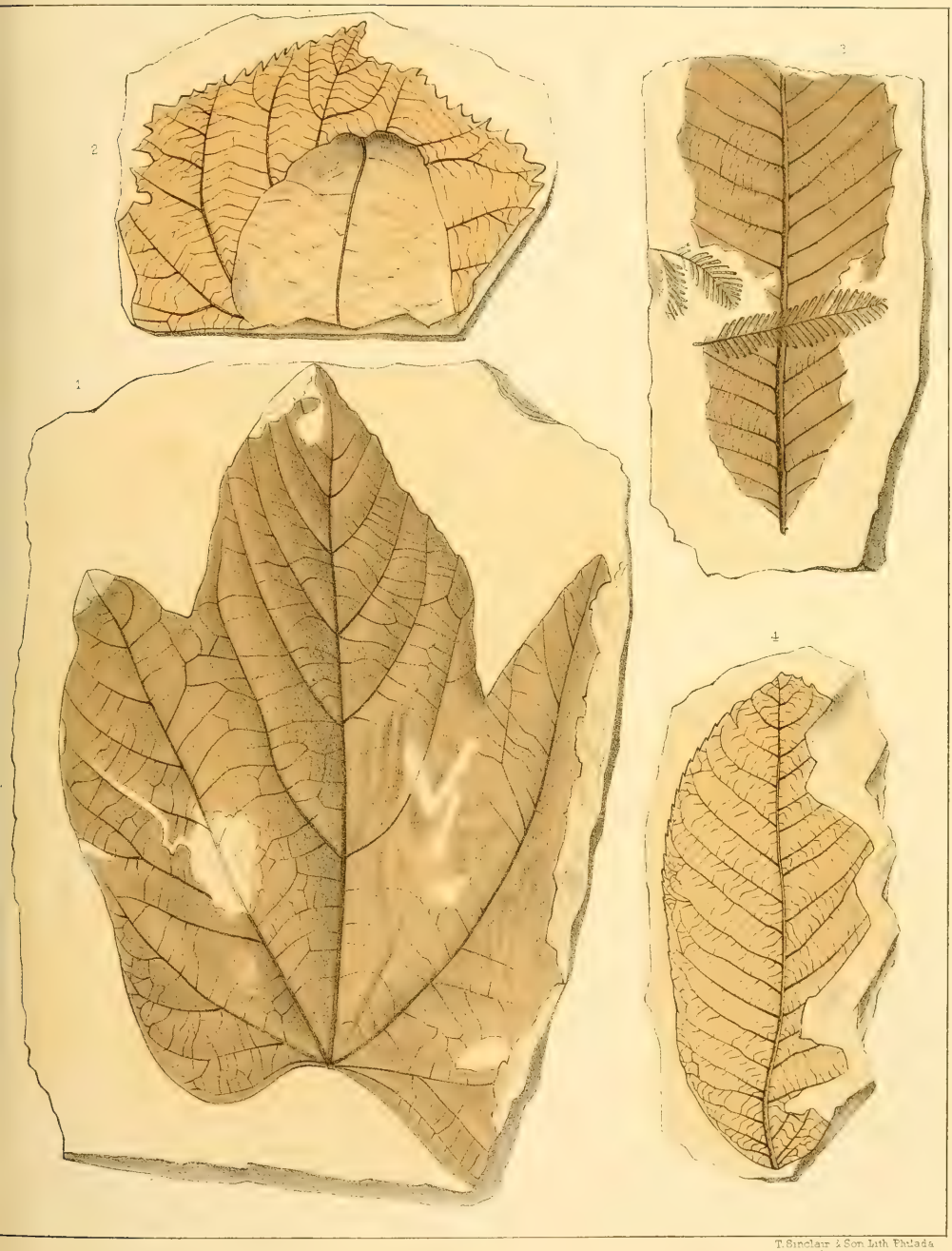

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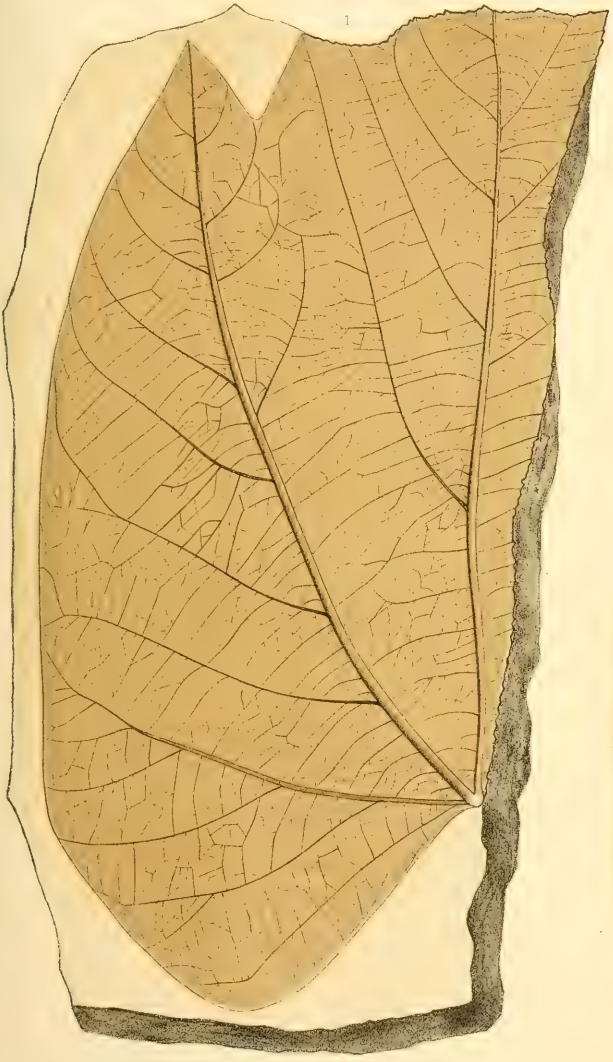

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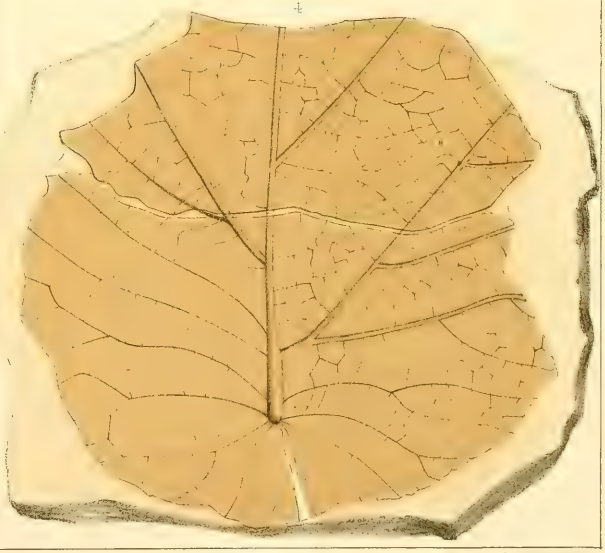

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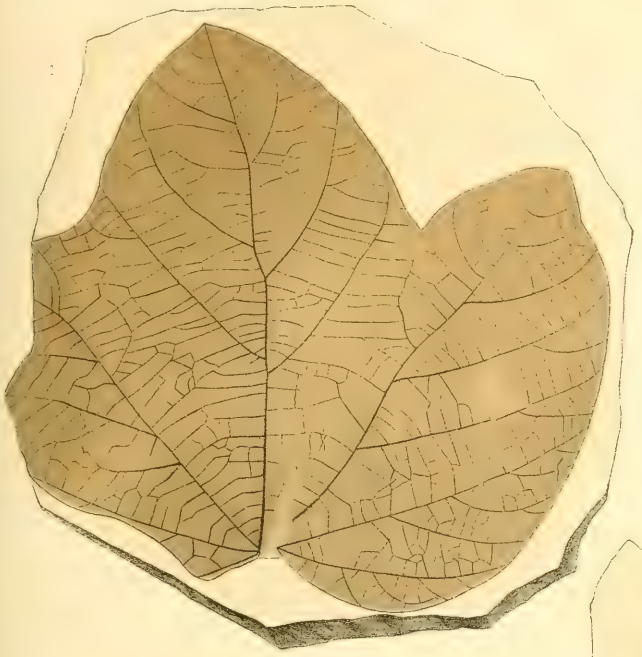

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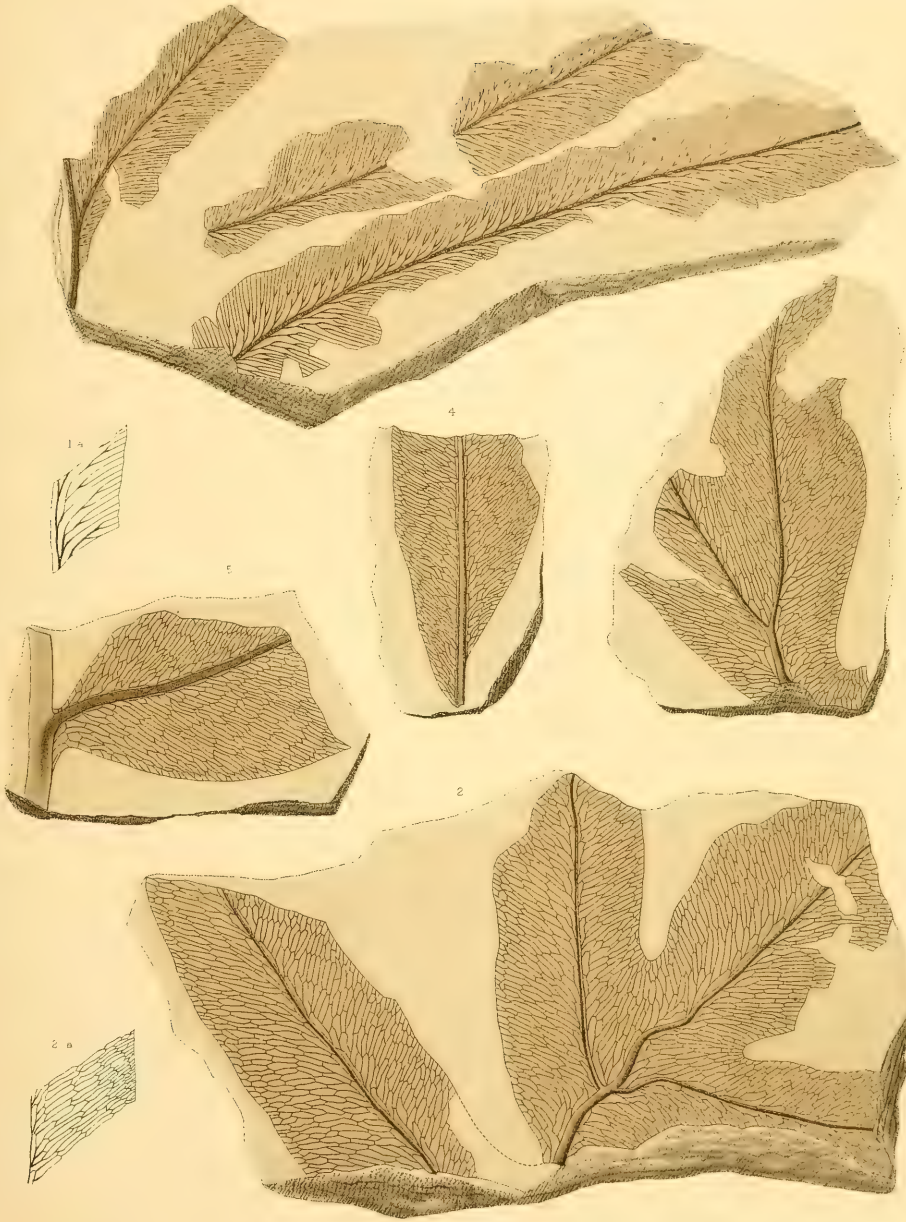

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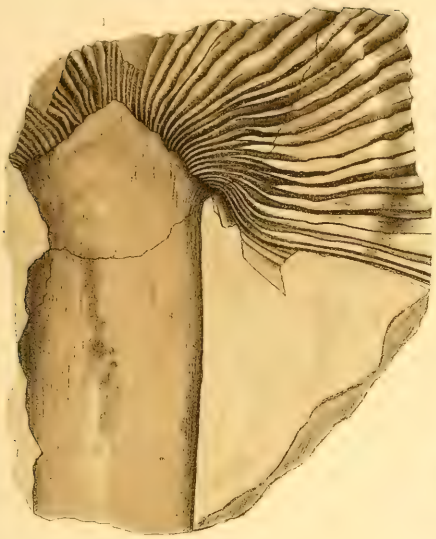

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[Monograph XXXV.]

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22. Sewage Irrigation, Part II, by George W. Rafter.
23. Water-Right Problems of Bighorn Mountains, by Elwood Mead.

TOPOGRAPHIC MAP OF THE UNITED STATES.

When, in 1882, the Geological Survey was directed by law to make a geologic map of the United States there was in existence no suitable topographic map to serve as a base for the geologic map. The preparation of such a topographic map was therefore immediately begun. About one-fifth of the area of the country, excluding Alaska, has now been thus mapped. The map is published in atlas sheets, each sheet representing a small quadrangular district, as explained under the following heading. The separate sheets are sold at 5 cents each when fewer than 100 copies are purchased, but when they are ordered in lots of 100 or more copies, whether of the same sheet or of different sheets, the price is 2 cents each. The mapped areas are widely scattered, nearly every State being represented. More than 800 sheets have been engraved and printed; they are tabulated by States in the Survey's "List of Publications," a pamphlet which may be had on application.

The map sheets represent a great variety of topographic features, and with the aid of descriptive text they can be used to illustrate topographic forms. This has led to the projection of an educational series of topographic folios, for use wherever geography is taught in high schools, academies, and colleges. Of this series the first folio has been issued, viz:

1. Physiographic types, by Henry Gannett, 1898, folio, consisting of the following sheets and 4 pages of descriptive text: Fargo (N. Dak.-Minn.), a region in youth; Charleston (W. Va.), a region in maturity; Caldwell (Kans.), a region in old age; Palmyra (Va.), a rejuvenated region; Mount Shasta, (Cal.), a young volcanic mountain; Eagle (Wis.), moraines; Sun Prairie (Wis.), drumlins; Donaldsonville (La.), river flood plains; Boothbay (Me.), a fiord coast; Atlantic City (N. J.), a barrier-beach coast.

GEOLOGIC ATLAS OF THE UNITED STATES.

The Geologic Atlas of the United States is the final form of publication of the topographic and geologic maps. The atlas is issued in parts, progressively as the surveys are extended, and is designed ultimately to cover the entire country.

Under the plan adopted the entire area of the country is divided into small rectangular districts (designated *quadrangles*), bounded by certain meridians and parallels. The unit of survey is also the unit of publication, and the maps and descriptions of each rectangular district are issued as a folio of the Geologic Atlas.

Each folio contains topographic, geologic, economic, and structural maps, together with textual descriptions and explanations, and is designated by the name of a principal town or of a prominent natural feature within the district.

Two forms of issue have been adopted, a "library edition" and a "field edition." In both the sheets are bound between heavy paper covers, but the library copies are permanently bound, while the sheets and covers of the field copies are only temporarily wired together.

Under the law a copy of each folio is sent to certain public libraries and educational institutions. The remainder are sold at 25 cents each, except such as contain an unusual amount of matter, which are priced accordingly. Prepayment is obligatory. The folios ready for distribution are listed below.

No.	Name of sheet.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
1	Livingston	Montana	110°–111°	45°–46°	3,354	25
2	Ringgold	Georgia, Tennessee	85°–85° 30′	34° 30′–35°	980	25
3	Placerville	California	120° 30′–121°	38° 30′–39°	932	25
4	Kingston	Tennessee	84° 30′–85°	35° 30′–36°	969	25
5	Sacramento	California	121°–121° 30′	38° 30′–39°	932	25
6	Chattanooga	Tennessee	85°–85° 30′	35°–35° 30′	975	25
7	Pikes Peak (out of stock)	Colorado	105°–105° 30′	38° 30′–39°	932	25
8	Sewanee	Tennessee	85° 30′–86°	35°–35° 30′	975	25
9	Anthracite-Crested Butte	Colorado	106° 45′–107° 15′	38° 45′–39°	465	50
10	Harpers Ferry	Virginia, West Virginia, Maryland	77° 30′–78°	39°–39° 30′	925	25
11	Jackson	California	120° 30′–121°	38°–38° 30′	938	25
12	Estillville	Virginia, Kentucky, Tennessee	82° 30′–83°	36° 30′–37°	957	25
13	Fredericksburg	Maryland, Virginia	77°–77° 30′	38°–38° 30′	938	25
14	Staunton	Virginia, West Virginia	79°–79° 30′	38°–38° 30′	938	25
15	Lassen Peak	California	121°–122°	40°–41°	3,634	25
16	Knoxville	Tennessee, North Carolina	83° 30′–84°	35° 30′–36°	925	25

No.	Name of sheet.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
17	Marysville	California	121° 30′–122°	39°–39° 30′	925	25
18	Smartsville	California	121°–121° 30′	39°–39° 30′	925	25
19	Stevenson	Alabama, Georgia, Tennessee	85° 30′–86°	34° 30′–35°	980	25
20	Cleveland	Tennessee	84° 30′–85°	35°–35° 30′	975	25
21	Pikeville	Tennessee	85°–85° 30′	35° 30′–36°	969	25
22	McMinnville	Tennessee	85° 30′–86°	35° 30′–36°	969	25
23	Nomini	Maryland, Virginia	76° 30′–77°	38°–38° 30′	938	25
24	Three Forks	Montana	111°–112°	45°–46°	3,354	50
25	Loudon	Tennessee	84°–81° 30′	35° 30′–36°	969	25
26	Pocahontas	Virginia, West Virginia	81°–81° 30′	37°–37° 30′	951	25
27	Morristown	Tennessee	83°–83° 30′	36°–36° 30′	963	25
28	Piedmont	Virginia, Maryland, West Virginia	79°–79° 30′	39°–39° 30′	925	25
29	Nevada City, Grass Valley, Banner Hill	California	121° 00′ 25″–121° 03′ 45″ 121° 01′ 35″–121° 05′ 04″ 120° 57′ 05″–121° 00′ 25″	39° 13′ 50″–39° 17′ 16″ 39° 10′ 22″–39° 13′ 50″ 39° 13′ 50″–39° 17′ 16″	11.65 12.09 11.65	50
30	Yellowstone National Park: Gallatin, Canyon, Shoshone, Lake	Wyoming	110°–111°	44°–45°	3,412	75
31	Pyramid Peak	California	120°–120° 30′	38° 30′–39°	932	25
32	Franklin	Virginia, West Virginia	79°–79° 30′	38° 30′–39°	932	25
33	Briceville	Tennessee	84°–84° 30′	36°–36° 30′	963	25
34	Buckhannon	West Virginia	80°–80° 30′	38° 30′–39°	932	25
35	Gadsden	Alabama	86°–86° 30′	34°–34° 30′	986	25
36	Pueblo	Colorado	104° 30′–105°	38°–38° 30′	938	50
37	Downieville	California	120° 30′–121°	39° 30′–40°	919	25
39	Truckee	California	120°–120° 30′	39°–39° 30′	925	25
40	Wartburg	Tennessee	84° 30′–85°	36°–36° 30′	963	25
41	Sonora	California	120°–120° 30′	37° 30′–38°	944	25
42	Nueces	Texas	100°–100° 30′	29° 30′–30°	1,035	25
43	Bidwell Bar	California	121°–121° 30′	39° 30′–40°	918	25
44	Tazewell	Virginia, West Virginia	81° 30′–82°	37°–37° 30′	950	25

STATISTICAL PAPERS.

Mineral Resources of the United States [1882], by Albert Williams, jr. 1883. 8°. xvii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.

Mineral Resources of the United States, 1885. Division of Mining Statistics and Technology. 1886. 8°. vii, 576 pp. Price 40 cents.

Mineral Resources of the United States, 1886, by David T. Day. 1887. 8°. viii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1887, by David T. Day. 1888. 8°. vii, 832 pp. Price 50 cents.

Mineral Resources of the United States, 1888, by David T. Day. 1890. 8°. vii, 652 pp. Price 50 cents.

Mineral Resources of the United States, 1889 and 1890, by David T. Day. 1892. 8°. viii, 671 pp. Price 50 cents.

Mineral Resources of the United States, 1891, by David T. Day. 1893. 8°. vii, 630 pp. Price 50 cents.

Mineral Resources of the United States, 1892, by David T. Day. 1893. 8°. vii, 850 pp. Price 50 cents.

Mineral Resources of the United States, 1893, by David T. Day. 1894. 8°. viii, 810 pp. Price 50 cents.

On March 2, 1895, the following provision was included in an act of Congress:

"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

In compliance with this legislation the following reports have been published:

Mineral Resources of the United States, 1894, David T. Day, Chief of Division. 1895. 8°. xv, 646 pp., 23 pl.; xix, 735 pp., 6 pl. Being Parts III and IV of the Sixteenth Annual Report.

Mineral Resources of the United States, 1895, David T. Day, Chief of Division. 1896. 8°. xxiii, 542 pp., 8 pl. and maps; iii, 543–1058 pp., 9–13 pl. Being Part III (in 2 vols.) of the Seventeenth Annual Report.

Mineral Resources of the United States, 1896, David T. Day, Chief of Division. 1897. 8°. xii, 642 pp., 1 pl.; 643–1400 pp. Being Part V (in 2 vols.) of the Eighteenth Annual Report.

Mineral Resources of the United States, 1897, David T. Day, Chief of Division. 1898. 8°. Being Part VI (in 2 vols.) of the Nineteenth Annual Report.

The money received from the sale of the Survey publications is deposited in the Treasury, and the Secretary of that Department declines to receive bank checks, drafts, or postage stamps; all remittances, therefore, must be by MONEY ORDER, made payable to the Director of the United States Geological Survey, or in CURRENCY—the exact amount. Correspondence relating to the publications of the Survey should be addressed to

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

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Author.

Newberry (John Strong).

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